MASTER THESIS

The professional identity development of STEM-students; identity status and development phase

An exploratory study in higher vocational education in the Netherlands

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Enschede, 13 May 2019

UNIVERSITY OF TWENTE.

Content

Acknowledgement

Abstract

In the technical industry of the Netherlands there is a shortage of highly educated technicians. The transition of students after graduation to a non-technical profession is seen as one of the reasons for this shortage. In the transition towards employment, the *professional identity* is seen as an important factor. The lack of a well-developed professional identity might lead for graduates to opt for a career in another domain, which consequently might cause a shortage of professionals in the technical domain. The professional identity can be seen as an individuals' definition about the concept professionalism, founded on a set of beliefs, knowledge, attitudes and skills. The quality of the transition largely depends on the students *professional identity development*, which can be seen as a process of evolvement. There is a need to bridge the knowledge gap on insights in the professional identity development of STEM (i.e. Science, Technology, Engineering and Mathematics) students, subsequently to provide them with the appropriate support. Therefore, the goal of this study was to investigate *the variations in the professional identity development of STEM students in higher vocational education, and how this is related to their academic year.*

The current study was exploratory in nature with a cross-sectional design and a mixed methods approach. In total 71 first- and third-year STEM higher vocational education students participated in the online survey; a quantitative measurement of the professional identity status and a qualitative measurement of the professional identity development as measured by an essay. The questionnaire consisted of validated scales with four dimensions: reconsideration of commitment, in-depth exploration, practices and level of identification.

This study showed that STEM students develop through different phases of professional identity development, which are characterized by; an internal vs. external defined professional self and the variations in the level of commitment and exploration. Students in academic year one revealed a higher need for reconsidering their commitment with the profession and to explore this commitment in-depth, through critical questioning their educational choices. While students of academic year three seem to have a higher feeling of belonging, the need for exploring alternative commitments reduces and in turn, undertake activities to discover specific career choices. Furthermore, this study proposes that the academic year (i.e. representing the students with and without internship experience) tends to be associated with the professional identity development, and that the internship experience may even accelerate the formation, but this needs to be further investigated. This study provides insights in the phenomenon of the professional identity development of STEM students in higher vocational education. On its turn, these insights provide understanding in where STEM students' growth opportunities lie and how to guide them in the wide range of choices they can make regarding potential professional routes.

Keywords: professional identity - professional identity development - vocational education - STEM students - status identity - moral development

1. Problem statement

Nowadays, the technology plays an important role in the lives of mankind. For example, in order to keep a sustainable earth and prevent global warming, technological methods are developed to make use of natural energy sources. But technology is also a booming business regarding the development of innovative products for use in daily life, for example smartphones. This creates a technical industry with a high influence on the economy (CBS, 2016). In the Netherlands the technical sector is responsible for about two fifth of the national products and two third of the export (CBS, 2016; Volkerink, Berkhout, Bisschip, & Heyma, 2013). This technology sector needs highly educated technicians. In the Netherlands there is a shortage of highly educated professionals in the technical sector, even more so with the growing economy (CBS, 2016; Volkerink et al., 2013). One of the reasons of this shortage is the transition from two out of five STEM (i.e. Science, Technology, Engineering and Mathematics) graduates to non-technical organizations and professions, e.g. a graduate in nanotechnology accepts a position in program management (Volkerink et al., 2013). The cause of this phenomenon is until now not really clear.

Research indicates that the transition process from school towards employment encompasses not only making career choices, but more importantly it involves commitment towards the profession (London, 1983; Orkibi, 2010). Therefore *professional identity* is seen as an important factor in understanding career choices (London, 1983; Orkibi, 2010). The lack of a well-developed professional identity might lead for graduates to opt for a career in another domain, which consequently might cause the shortage of professionals in the technical domain. Professional identity can be seen as an individuals' definition about the concept professionalism, founded on a set of beliefs, knowledge, attitudes and skills (Ibarra, 1999). The transition process might be a possible conflicting task manifesting in a crisis regarding the career choices students should make (Mancini, Caricati, Panari, & Tonarelli, 2015; Silva & Teixeira, 2013). The quality of this transition largely depends on the students professional identity development (Bebeau & Lewis, 2003; Silva & Teixeira, 2013). Therefore, the *professional identity development* plays an important role in gaining a strong professional identity (Ashforth, Harrison, & Corley, 2008; Bebeau & Lewis, 2003). The professional identity development process is a complex concept investigated by multiple disciplines in different fields of expertise (e.g. dentists), hence the professional identity development of STEM students has not yet been researched much. Therefore, there is a need to gain more insight in the professional identity development in order to be able to support the STEM students towards a successful accomplished and a well-developed professional identity. Accordingly, this study adds to the body of knowledge on professional identity development of STEM students, in the context of higher vocational education.

In recent time vocational education in the Netherlands has reformed their education, from traditional education (transition of formally acquired knowledge) towards a new form of learning (competence based curriculum) (Mittendorff & van der Sanden, 2006). This entails a change for students, i.e. whom are now responsible for their own learning development, and teachers, i.e. whom

have to shift to the role of coach (Mittendorff & van der Sanden, 2006). This new education focusses on the development of students, by learning students to become a reflective-practitioner (Mittendorff & van der Sanden, 2006). This is a learning process in which the students reflect upon their professional identity, such as their moral values, interests, motives and uncertainties (Mittendorff & van der Sanden, 2006). However, even though self-development is promoted in vocational education, the reflection methods students conduct in their education is the same for all students, regardless of the phase of their professional identity development. The phase of development are often not considered in the curriculum of higher vocational education, although these are essential in understanding the students' involvement with their education and professional identity development. It is important that students receive suitable support at the right moment in their professional identity development in order to be effective (Loui, 2005). Furthermore, professional identity development can be fostered by several factors. Internship experience is one of the factors that has a high influence on professional identity development, especially for STEM students because they seem to learn from the workplace environment and its characteristics, e.g. working with colleagues and being perceived as a professional (Loui, 2005). Each phase and transition phase in the development can be identified with certain characteristic features, e.g. need for guidance in exploring career choices. Having knowledge about the different phases of professional identity development STEM students go through, offers study counsellors with knowledge to adjust their counselling support to guide students in the wide range of choices they can make regarding potential professional routes. Therefore, the goal of this study is to obtain knowledge about the variations in the professional identity development of STEM students in higher vocational education and how this is related to their academic year.

2. Theoretical framework

In this chapter two concepts will be discussed; professional identity and professional identity development, followed by a discussion of two theories and measures on professional identity development. In the last paragraph, the influence of internship experience on professional identity development will be discussed.

2.1 Professional identity

Erikson (1950) describes the identity as a sense of being a unique and cohesive inner person, in a turbulent and changing environment, and that this sense corresponds with how others perceive the individual. In forming an identity, individuals negotiate conflicting demands and tensions between multiple identities whereby a new identity is constructed (Bebeau & Lewis, 2003). This can be seen as a continuous process of forming, repairing, strengthening or revising the constructions of the identity, which creates a sense of coherence and distinctiveness (Sveningsson & Alvesson, 2003). Throughout their lives, individuals construct multiple identities that are related to different domains in their life. The degree of intensity, i.e. the effort spent in the role and integration between the role and self, determines what the central identities of a person are (Ebaugh, 1988; Ibarra, 2007). Thus, some identity roles are relevant only in specific situations, while other identity roles are intertwined with an individuals' self-definition, e.g. professional identity in work environment (Ashforth & Johnson, 2001; Ibarra, 2007).

Professional identity is a multifaceted complex concept investigated by different disciplines with different perspectives, consequently many definitions exist in literature. The most cited researchers in this topic define professional identity as one's professional self-concept based on attributes, beliefs, values, motives, and experiences that are representative of professionals within a profession (Nadelson et al., 2015). Ibarra (1999) contributes to this notion that this is a dynamic and ongoing process of development (Nadelson et al., 2015). According to Ashforth et al. (2008) professional identity is constituted out of two dimensions, which are strength (a.k.a. the core) and content. The strength regards one's self-definition as a professional (Ashforth et al., 2008). The content entails one's self-concept, constituted out of five dimensions: personality, interests, values, competencies and skills (Ashforth et al., 2008). Recent research provided more insight in the content and strength of professional identity of STEM students (Möwes, van Veelen, & Endedijk, 2017; van 't Hul, 2017). These studies investigated the five content domains of professional identity on large scale and identified five types of STEM students (Möwes et al., 2017; van 't Hul, 2017). Furthermore, these studies revealed that STEM students with a strong professional identity were more likely to opt for a technical career (Möwes et al., 2017; van 't Hul, 2017). Yet, obtaining a strong professional identity is not simplistic with a clear-cut answer, but a process of evolvement. This process is seen as the professional identity development in which the individual goes through several phases while the strength and content dimensions of the professional identity are in construction (Bebeau & Lewis, 2003; Mancini et al., 2015). In the following paragraph the professional identity development will be discussed in more detail.

2.2 The professional identity development

The theoretical frameworks about professional identity development (a.k.a. professional identity formation) have been developed over the last fifty years. The founders of these theories were informed by constructive-developmental theories; Erikson's theory of social-emotional development, Kohlberg's theory of moral development and Piaget's theory of cognitive development. In general, professional identity development is seen as a continuous process that takes place among two extremes, as Erikson describes "between the role confusion (absence of a stable identity) and identity synthesis (successful accomplishment of an identity)" (Erikson, 1950; Klimstra et al., 2010, p. 191). The constructive-developmental theories' main theme concerns the ability of individuals "to actively create moral meaning that grows in stages that represent increasing complexity of thought" (Kalet et al., 2018, p. 12). Researchers indicate that the level of professional identity achieved by an individual, can be seen as the degree an individual has internalized aspects of a profession (Nadelson et al., 2015). In other words, the strength and content of the professional identity increases as one progresses through the development phases; becoming a self-defining professional (Ashforth et al., 2008; Bebeau & Lewis, 2003). For students in higher vocational education this means that they become more and more capable of understanding and handling complex problems (Kalet et al., 2018). Subsequently, their behaviour in a professional role becomes consistent with the expectations of that profession (Baxter Magolda, 2008; Kalet et al., 2018). Therefore, it is important that students are involved and supported in complex experiences, e.g. internship, fieldwork (Kalet et al., 2018). Following, two theories and measures on professional identity development will be discussed in the following paragraphs.

2.3 Theories and measures on professional identity development

2.3.1 The professional identity status. Erikson developed the "ego identity theory" for explaining the psychosocial development of the human. This theory describes the predetermined order of phases an individual goes through. To build upon the previous stage and go to the next, an individual undergoes an identity crisis; the presence of identity feeling versus role confusion (Crocetti, Rubini, Luyckx, & Meeus, 2008). Subsequently, the identity crisis event leads to an internal conflict which causes the individual to examine and question his/her believes, values and goals (Crocetti, Schwartz, Fermani, & Meeus, 2010). The exploration, by examining and questioning, leads to new beliefs, values and choices and the commitment towards a new identity.

In the 60's Marcia built "the status identity theory" based upon the theory of Erikson. Instead of focusing on the outcomes as Erikson did, Marcia put the focus on the process of development (Crocetti et al., 2008; Marcia, 1966). Marcia's theory suggests that identity formation depends on two behavioural indicators, which are 1) *exploration*, which refers to the extent to which an individual weighs and thinks about options regarding the variety of identity possibilities, prior to making decisions about the values, beliefs and goals that one pursues, and 2) *commitment*, which refers to the level of opting certain choices belonging to an identity (Crocetti et al., 2010; Mancini et al., 2015; Marcia, 1966). Marcia developed the identity status interview (ISI), a semi-structured interview in order to measure the

individuals' identity status (Meeus, 1996). The degree to which an individual has explored and committed to an identity, determines the status in which an individual internalizes and forms an identity (Marcia, 1966). In other words, the level of exploration and commitment, represented in low or high (see Figure 1), classifies an individual into one of the four identity statuses: 1) *Diffusion*, in which an individual has no exploration or commitment to roles and values of the profession, 2) *Foreclosure*, in which the individual has made commitment to the roles and values of the profession, but without exploration, 3) *Moratorium*, in which an individual explores the roles and values of the profession, but without making commitment, and 4) *Achievement*, in which an individual has explored the roles and values of the profession, in which commitment is subsequently made (internalized profession) (Mancini et al., 2015; Marcia, 1966).

In the last 20 years, researchers have proposed adjustments and expansions of Marcia's original model (Mancini et al., 2015). One of the most important contributions to Marcia's model was done by Meeus (2001) and Crocetti et al. (2008). Where Marcia's model proposed that developing an identity starts from "tabula rasa", Meeus (2001) and Crocetti et al. (2008) rather see the identity development as a dynamic process by building on prior knowledge. To capture this dynamic process, where the identity is formed and revised over time, Meeus (2001) transformed Marcia's two dimensional model in a three dimensional model, which includes commitment, in-depth exploration and reconsideration of commitment (see Figure 2) (Crocetti et al., 2008). This proposition was based on earlier research of Meeus (1996), whom suggested that an individual might continue to explore after they have committed to a profession. This was confirmed by Luyckx, Goossens, Soenens, and Beyers (2006), they found that the exploration dimension consisted of two types: in-breadth and in-depth exploration. Subsequently, this was integrated in the three-dimensional model of Meeus (2001) and evidence for this model was verified by him and his colleagues (Crocetti et al., 2008). The dimension *commitment* refers to making a solid choice for a certain identity, undertaking activities that focus on the application of that identity choice and the self-assurance that comes forth of making these choices (Crocetti et al., 2008; Mancini et al., 2015; Marcia, 1966). The dimension *In-depth exploration* refers to the level to which individuals reflect upon their current commitments and searches for information and shares personal choices one made regarding the identity (Crocetti et al., 2008). The dimension *Reconsideration of commitment* refers to the comparison of present commitments with alternative commitments, because the current ones (e.g. goals, values, beliefs) are no longer satisfactory (Crocetti et al., 2008).

In summary, the dynamic process begins with an individual exploring in-depth identity options, followed by a round of active self-questioning whether these options might fit with their capacities (Mancini et al., 2015). When there is a fit, this leads to commitment to this profession. However, when there is not a fit or when one wants to revise its current commitment, the individual might reconsider his/her choices and opt for commitment with possible other identities (Mancini et al., 2015). The latter phase of reconsideration is added by Crocetti et al. (2008) as the fifth status; *searching moratorium*, in which the individual revises the commitments he/she made towards an identity (see Figure 1).

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                        Commitment
                  High                Low

        High              ⇐ Searching ⇒
                            Moratorium

                  Achievement        Moratorium

Exploration


        Low       Foreclosure        Diffusion
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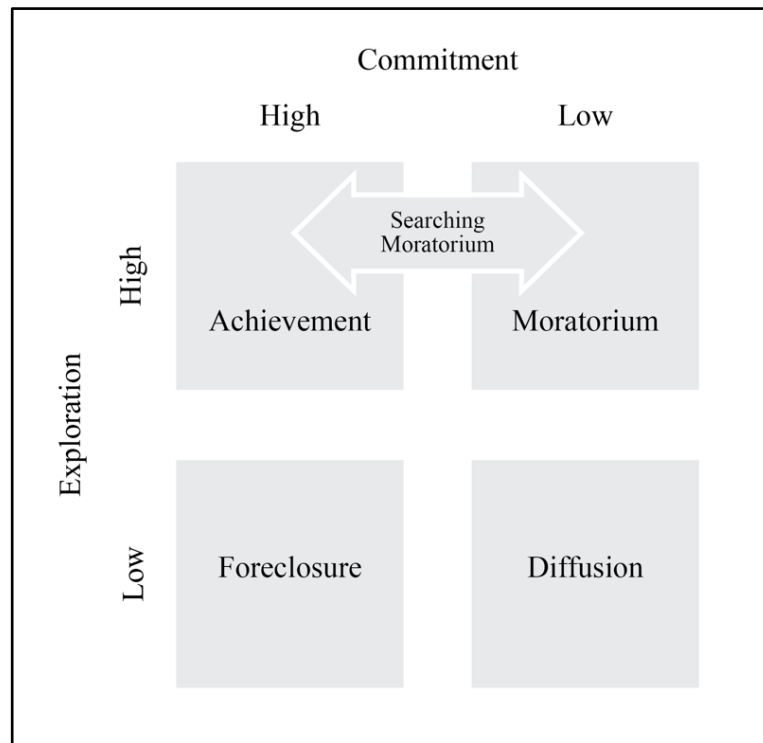
Figure 1. The professional identity status theory (adapted from Mancini et al., 2015; Marcia, 1966)

More recently, Mancini et al. (2015) expanded the theory of Marcia and the later revisions of the model (Crocetti et al., 2008; Meeus, 2001), by applying the identity status framework to the domain of the professional identity development. Most of the research done in the identity development focusses on the intra-personal processes, however the theory of Mancini et al. (2015) is one of the first models that includes the intra-personal dimension, as well as the inter-personal dimension. They address the importance of the individual processes as well as the social dynamics in the professional identity development, e.g. group identification, social comparison (Mancini et al., 2015). Therefore, they have created a five-dimensional model by adding two extra dimensions. An overview of the evolvement of the dimensions of the identity status theory are illustrated in Figure 2 (adapted from Veldhorst, 2016). The first dimension, *affirmation*, is about what one contributes to the profession one belongs and a sense of pride in that profession (Mancini et al., 2015). The second dimension, *practices*, concerns the behavioural involvement in the form of undertaken activities towards the profession, e.g. participating in meetings/conferences/in-service training (Mancini et al., 2015). This resulted in a measure for determining the identity status; the Professional identity status questionnaire (PISQ-5d). The instrument was confirmed on validation by Mancini et al. (2015), as it revealed adequate psychometric properties regarding the identity statuses.
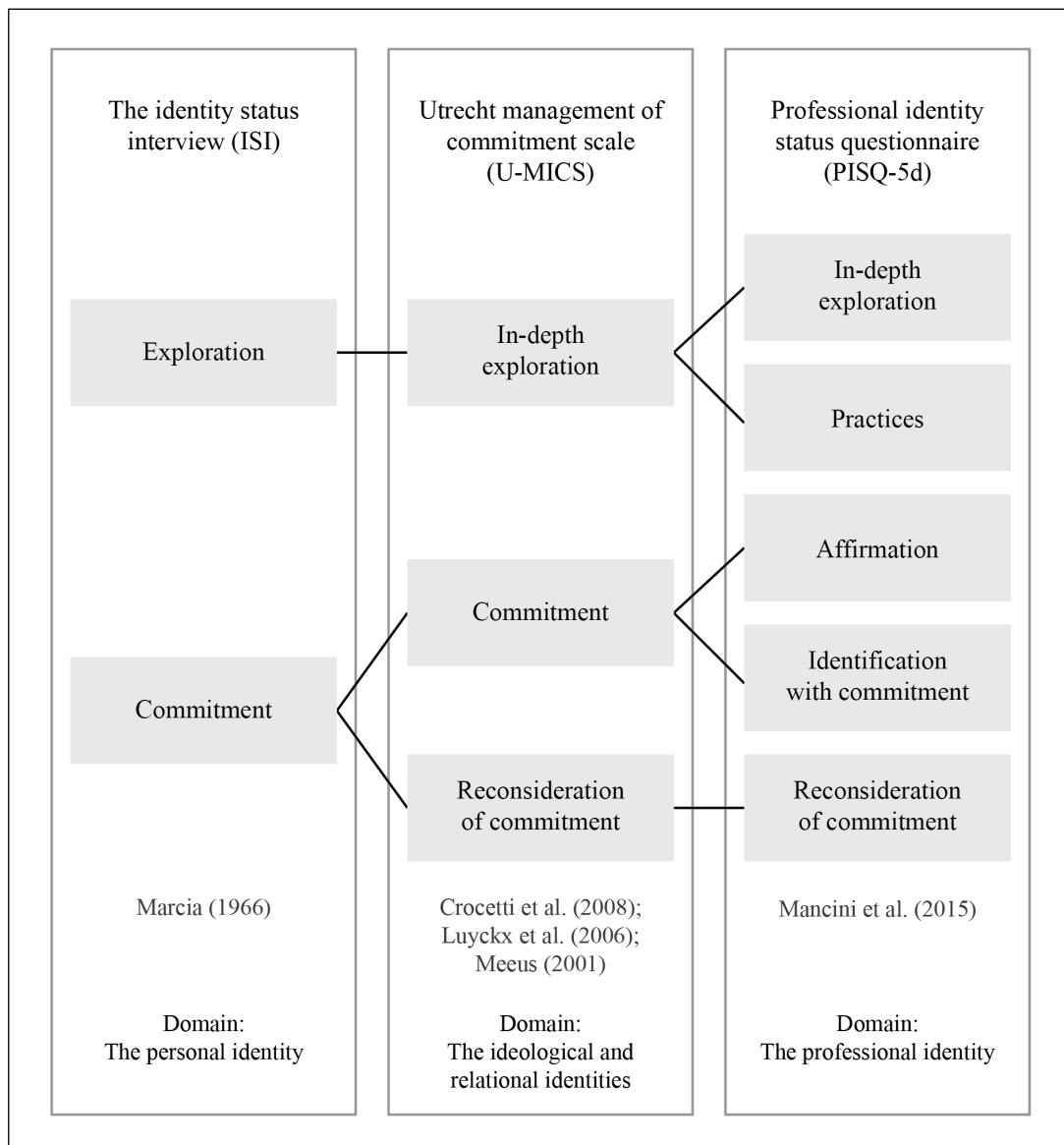
Figure 2. The evolvement of the dimensions of the identity status theory

2.3.2 The professional identity development phase. Kegan developed the "Constructive development theory" for adulthood development based on work by Piaget, Kohlberg, and Maslow (Bebeau & Lewis, 2003; Berger, 2002; Kegan, 1982). Kegan suggests that the development takes place over five distinct stages on three dimensions, i.e. cognitive (nature of knowledge), intra-personal (one's own beliefs, values, goals) and inter-personal (the beliefs, values and goals of others that are known) (Berger, 2002). The framework is built on the theorem that being able to transition to a higher stage of development a subject-object shift is required (Berger, 2002; Kegan, 1994). The *subject* refers to consciousness of self-concepts, therefore you can reflect and act upon them. Whereas the *object* refers to unconsciousness of self-concepts, e.g. how we make meaning of our experiences (Berger, 2002). Through the development of the five stages, via the subject-object shift, an individual develops an independent sense of the self, e.g. becoming self-aware, locus-of-control (Kegan, 1994; Kroger, 2002).

Kegan's theory suggests that the development of the identity proceeds from an egocentric view to a social oriented view (Berger, 2002).

Bebeau and Lewis (2003) adapted Kegan's theory of identity development of adulthood to the domain of *professional identity development*. This theory is based on the assumption that the ethical cognition of the professional arises from the core of the identity, which is seen as the basis for identification (Ashforth et al., 2008; Bebeau & Lewis, 2003). Suggesting that a process of tension solving occurs while the individual constitutes a professional identity: negotiation takes place between the self and others regarding responsibilities and expectations that fall within the domain of ethical and moral reasoning (Bebeau & Lewis, 2003). The theory of Bebeau and Lewis (2003) exists of four phases and three transition phases, see Figure 3.
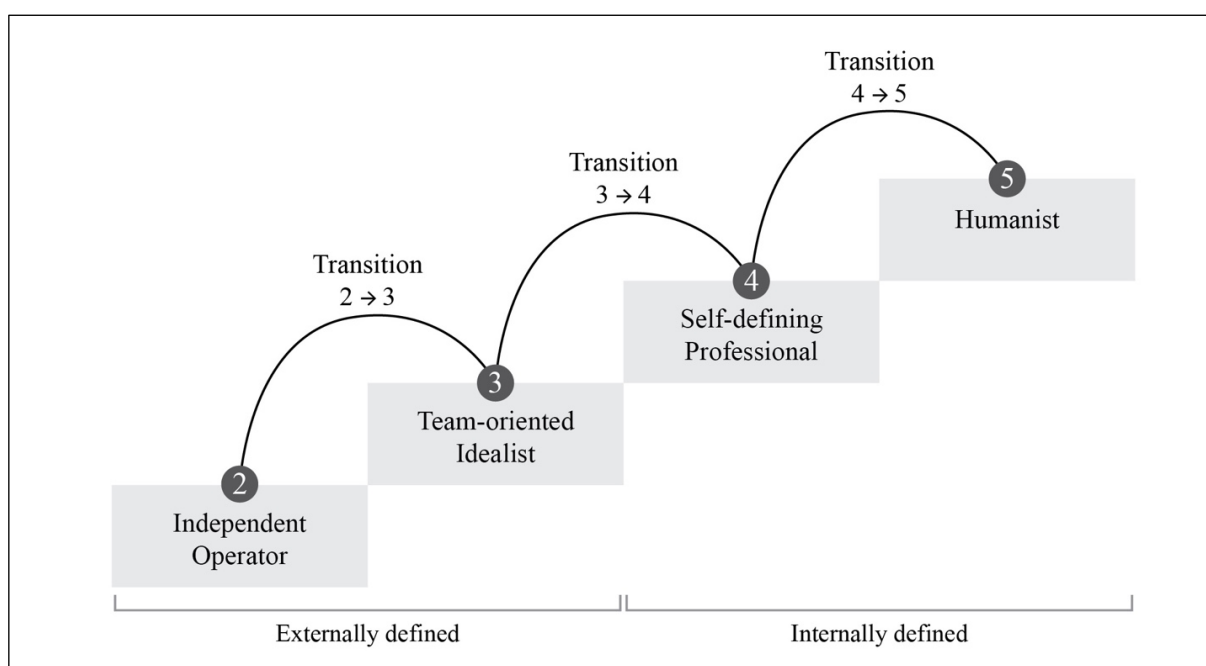
Figure 3. The professional identity development (adapted from Bebeau & Lewis, 2003; Kegan, 1982)

The four phases correspond with the last four out of five phases of Kegan: the first phase concerns child development, whereas the adulthood development starts from phase 2. Therefore, the first stage of Bebeau and Monson (2012) starts with phase 2. The first phase, *phase 2 the independent operator*, the individual operates with an egocentric perspective according to external definitions of self and of professionalism, with the aim of receiving external rewards. The individual draws a sense of meaning from group belonging and sees others as persons with their own interests (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). The intermediate phase, *transition phase 2/3*, the individual has a greater understanding of the professionalism and the role of the self, but has not yet the ability to handle with the shortcomings that prevent the individual to fully internalize a profession (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). The second phase, *phase 3 the team-oriented idealist*, the individual is engaged in social interactions and connectedness. Through this social sharing, the individual has the

ability to take a more social perspective, which gives it the ability to empathize with others. The individual internalizes the social expectations and ideals (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). The intermediate stage, *transition phase 3/4*, the individual possesses a greater understanding of self, regarding his/her professionalism. The individual retrieves a greater level of awareness and the ability to identify aspects that influence the individuals' integrity, but is not yet able to resolve them (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). The third phase, *phase 4 the self-defining professional,* the individual at this stage has developed a system in which the personal and professional values are integrated, but his/her identity is not yet totally embedded in the profession. The individual possesses the skills to take multiple perspective simultaneously, which gives him/her the ability to empathize with others. The individual reflects upon the professional practice and can make autonomous decision without the influence of others. This phase is essential for a successful professional identity (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). The intermediate phase, *transition phase 4/5*, the individual has an increasing ability to notice and harmonize multiple contradictory ways of thinking and being. But, the individual is often identified with his/her own self-system, he/she organizes his/her live by certain values and principles and therefore finds it difficult to deviate from his/her self-system (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). The fourth phase, *phase 5 the humanist,* the individual is aware of his/her own limits regarding ideology of the profession and possesses self-criticism. In this phase the individual recognizes the interconnections between the different systems. The individual has the ability to reconcile conflicting manners of meaning making (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). Thoma and Bebeau (2013, p. 490) suggest that the person who reaches this stage is "open to entertaining contradiction and seeing the merits of alternative systems and perspective", which might lead to the evolvement of becoming a leader in the profession. The first two phases are characterized by an ego-centric view and the identity is externally defined, on contrary the latter two phases are characterized by independence of judgement and expectations of others; the identity is self-defined (towards one's inner moral code) (Bebeau & Lewis, 2003).

As the individual proceeds in the developmental phase, the moral reasoning increases; the understanding for professional responsibility shifts from individual liability of blame towards broader sense of justification for society (Bebeau & Lewis, 2003; Loui, 2005). Furthermore, the transition phases that are positioned between the phases are expressed by Bebeau and Monson (2012, p. 152) as "the process of encompassing one's current way of making meaning within the broader and more complex framework of the next developmental stage". Typically the transition phases last approximately several months. Earlier research indicates that college students, aged 18 – 24, are often positioned in the transition phase 2/3, i.e. between phase 2 independent operator and phase 3 the team-oriented idealist (Bebeau & Monson, 2012; Forsythe, Snook, Philip, & Bartone, 2002). On contrary, the early to mid-career professionals are often positioned in the transition phase 3/4, i.e. between phase 3 the team-oriented idealist and phase 4 the self-defining professional. While phase 4, the self-defining professional, is often achieved after mid-career (Bebeau & Monson, 2012; Forsythe et al., 2002).

Research indicates that it is important that students receive the suitable support at the right moment in their professional identity development in order to be effective (Loui, 2005). Therefore, it is important to gain understanding of the transitions students are going through, in order to help them being able to cope with the changes (Loui, 2005). Each phase of development requires a different strategy to support the individual towards a higher phase of professional identity development (Bebeau & Lewis, 2003). It is therefore important to gain insight in the professional identity development of STEM Students, in order to provide them with the suitable support.

Bebeau and Lewis (2003) developed the professional identity development essay instrument. They developed the instrument for dual purpose; for measurement and for student development as a summative assessment e.g. providing constructive feedback (Hamilton & LaVoi, 2017; Monson & Hamilton, 2011). The professional identity development theory of Bebeau and Lewis (2003) has been applied in multiple studies. The first studies were done in the domain of Harvard MBA students and professional military cadets. Thereafter, the studies were conducted in the educational domain, e.g. dental students, law students, with age range 20-25, but not yet in the domain of STEM (Hamilton & LaVoi, 2017; Monson & Hamilton, 2011). Results from the studies in the educational domain revealed that the largest group of the participants were located in the transition phase 2/3 (Monson & Hamilton, 2011).

Kegan (1982) developed the theory based on age predetermined phases; typically stage 2 to 3 occurs in adolescence with spout to adulthood; Stage 3 often observed in late adolescence and according to Kegan, the predominant stage of most adults; Stage 4 is often only obtained from the age of 30 and Kegan suggests that only half of the adults might reach this stage (Monson & Hamilton, 2011). However, recent studies revealed that the development phase of the identity significantly differs in age groups; suggesting that an individual with the age of 20 can have obtained a phase 4, while an individual with the age of 50 remains in phase 2 (Monson & Hamilton, 2011). Taken that into account, it is expected that the professional identity development of STEM students ranges between phase 2 and phase 3.

2.3.3 A two-sided view; similarities and contradictions. Both theories on professional identity development provide insight into the formation of the professional identity. Both indicate that the development is combination of two processes: 1) the intra-personal process; where the identity is developed through individuals' cognitive processes e.g. beliefs and values, and 2) the inter-personal process; where the identity is formed by social dynamics (Bebeau & Lewis, 2003; Mancini et al., 2015). Another similarity between the two theories is the description of phases in which the identity is externally defined vs. self-defined, meaning that as the individuals' level of strength and content of his/her professional identity increases, the individual becomes a self-defining professional (Ashforth et al., 2008; Bebeau & Lewis, 2003. What also is equivalent in both theories is the event or/and crisis in the development that leads to the next phase of internalizing a professionally identity. Mancini et al. (2015) describe that the identity crisis occurs when an individual feels that his/her current commitments does not meet his/her values and beliefs and therefore is not satisfying anymore, represented in the

(searching) moratorium status. Bebeau and Lewis (2003) suggests that the individual makes meaning of an event within the framework of the next more complex developmental stage, which guides the individual via transition into the next phase (Bebeau & Monson, 2012).

Furthermore, both theories have a main theme from which the theories origins; the identity status theory focusses on the level of commitment and exploration, whilst the professional identity development phase pinpoints the importance of the moral development. One could say that both themes are intertwined; it is necessary that the individual is able to weigh options and think critically, in which a crucial role is reserved for the moral, in order to be able to enter into commitment and exploration (Leman, Bremner, Parke, & Gauvain, 2012). The moral is seen as right and wrong judgement, it is developed via a complex process that is determined by maturation, neurological development, personality traits and biological factors (Leman et al., 2012). The neurological development of the brain is seen as influential and takes place over adolescence and evolves into adulthood; a process of myelination in the prefrontal cortex (Leman et al., 2012). Traditionally it was thought that the myelination process ends with the beginning of adulthood. However, over the last decades, brain research discovered that the process of myelination remains active during adolescent life (Arain et al., 2013). This aspect shines light on a contradiction between both theories; the timeline of development. Bebeau and Lewis (2003); Kegan (1982) suggest that gaining a successful professional identity is a lifelong process and varies across the age ranges of life, where Marcia (1966) indicates that around the age of 18 – 22 the identity should be achieved. Another contradictory aspect is that the theory of Bebeau and Lewis (2003) regards the consecutive phases of development an individual goes through, whereas the theory of Mancini et al. (2015) regards the style an individual adopts towards a certain profession. Follow up studies discovered that although the identity status theory fails to provide a developmental theory, it is capable of describing developmental trends; transitions in developmental shifts (Meeus, 1996; Waterman, 1982). For example, an individual in a moratorium status; where the exploration level becomes weaker, transitions to diffusion status, or; where the commitment level increases, transitions to the achievement status (Meeus, 1996).

To conclude, despite some contradictions between both theories, their origin arises from constructive-developmental theories and therefore contain the same themes. But, there has not yet been a study in which both measures were involved. There is some research in which the predecessors of both measures and/or themes were involved and studied, but these are limited. Kroger (2002) studied the association between the theory of Kegan (1982) and theory of Marcia (1966). This research indicated that the two theories are positively related; stage 1 and 2 of Kegan were associated with the diffusion status of Marcia, stage 3 was associated with foreclosure status, stage 4 was associated with moratorium status and stage 5 was associated with the achievement status (Kroger, 2002). One other important outcome suggests that the transition phases of the development process described by Kegan, are construction phases which can be seen as the moratorium identity status of Marcia (Kroger, 2002).

The theory of Kegan (1982) and Bebeau and Lewis (2003) was based on, inter alia, Kohlberg's theory of moral reasoning. A meta-analysis was done by Jespersen, Kroger, and Martinussen (2013) to

investigate the relationship between identity status theory of Marcia and the theory of moral reasoning by Kohlberg (Kroger & Marcia, 2011). Kohlberg's theory suggest that there are three stages of moral reasoning an individual goes through during natural maturation; pre-conventional (the needs of the self are considered right), conventional (right or wrong decisions based on social group or laws of the social environment) and post-conventional (judgment arises from broader principles and universal standards) (Kroger & Marcia, 2011). Results revealed that the identity status *achievement* was significantly more likely to be reasoning at post-conventional levels of moral reasoning than non-post-conventional levels (Kroger & Marcia, 2011). Furthermore, a correlation was found between identity status and moral reasoning (Kroger & Marcia, 2011). This study investigates the relation between the two theories on professional identity development by Mancini et al. (2015) regarding the identity status and by Bebeau and Lewis (2003) regarding the phase of development.

2.4 Fostering professional identity development: internship

As one progresses in life, an individual naturally develops a professional identity in performing an employment. However, previous research indicates there are several factors that stimulate the level of professional identity development, e.g. gender, personality, self-efficacy. One concept stands out and is seen as the most influential factor on professional identity development; gaining experience in the fieldwork. When students enter the professional domain for the first time, it gives them the opportunity to experience the identity of the profession. It provides them with the opportunity to negotiate with the professional and personal selves (Dehing, Jochems, & Baartman, 2013). Internship experience has a major influence on the professional identity development, because students primarily learn about professionalism from colleagues and co-workers and less from technical engineering courses (Loui, 2012). Interestingly, STEM students value and characterize integrity and honesty equal with technical competences as important characteristics of engineers (Loui, 2005). Especially in the field of engineering students, workplace learning revealed a major influence on identity development and the transformation of students; from engineering students to student engineers (Dehing et al., 2013). Importantly, is that the level of professional identity development is matched with the type of internship/fieldwork in order to be effective, e.g. role-emerging placements is another example of internship experience in which the senior students (with a higher level of professional identity), expand their practice into innovative settings (Clarke, Martin, Sadlo, & de Visser, 2014). Research indicated that the internship provides the students with role-models; to observe the professional traits and behaviours, and to internalize these aspects in their professional identity (Ibarra, 1999). Due to the changing society, professional identity develops more and more towards a fluid identity in which the individual beholds multiple professional roles (Ibarra, 2007). Therefore, it is important that STEM students are prepared for the 21st century work field and use many different workplace learning opportunities in their education to grasp and internalize values and norms of different companies and institutions, to construct a strong and solid professional identity (Ibarra, 2007).

Typically, STEM students in higher vocational educational in the Netherlands follow an internship in academic year three and four, which seems rather late and with possible consequential effects for the professional identity of students. This was studied by Dehing, Jochems, and Baartman (2013), where the influence of workplace learning on the identity of higher vocational engineering students in the Netherlands was investigated. It was expected that students with high score on identity would develop more through workplace learning. However, they found that students with a high score on identity slowed down and developed less, on contrary students with a low score made a catch up (Dehing et al., 2013). This was possibly explained by the fact that identity development does not receive sufficient attention during the courses of the first two academic years, resulting in students that initially developed high identity scores (Dehing et al., 2013). But, these high scores were built on the wrong expectations of the profession. Consequently, through workplace learning these expectation were corrected, resulting in lower identification scores (Dehing et al., 2013).

To conclude, internship experience seems to be a crucial factor in the development of an professional identity. Therefore, this study also investigates whether STEM students with and without internship experience reveal different outcomes on the professional identity development by including the variable academic year (i.e. first- and third-academic year students).

2.5 Research question

This exploratory study aims to answer the following research question:

What are the variations in the professional identity development of STEM students in higher vocational education? And how is this related to their academic year?

Through the exploratory nature of this study the following sections were investigated in this study:

- The different variations in the professional identity statuses of STEM students
- The different variations in the professional identity development phases of STEM students
- The relationship between the professional identity status and the professional identity development phase
- The relationship with students' academic year (i.e. representing students with and without internship experiences) and the professional identity status, and the professional identity development phase.

3. Method

3.1 Research design

As the aim for this study was to explore and capture different facets of the professional identity development of STEM students two different research methods were used. The first method was a quantitative instrument for measuring the professional identity status via a questionnaire. The second method was a qualitative instrument for measuring the professional identity development phase via an essay. With a cross-sectional design, both methods were conducted at the same time and were prioritized equally (Onwuegbuzie & Collins, 2007). Together, these two methods formed a mixed methods approach to examine and address different parts of the phenomenology of the professional identity development of STEM students (Creswell, 2009; Onwuegbuzie & Collins, 2007). First, the quantitative and qualitative data were gathered and analysed separately. Following, the point of interface arises where the results from the analysis were merged, compared and interpreted to explore what the combined sets of findings indicate about the professional identity development of STEM students (Onwuegbuzie & Collins, 2007). Therefore, the convergent (concurrent) parallel design was used for determining the mixing strategy. The relationship between the qualitative and quantitative samples was identical, i.e. for both the qualitative and quantitative part of the study the same sample members participated (Onwuegbuzie & Collins, 2007). As the current study is an exploratory study with a qualitative and quantitative part, the subject to item ratio 3:1 for this study seems appropriate (Field, 2009). The selection of the sample size for this study was based on a collection of interpretive studies with the same design as in the current study (Onwuegbuzie & Collins, 2007; Onwuegbuzie & Leech, 2007).

3.2 Participants

As the aim for this study was to research the professional identity development phenomenon specifically for STEM students, we strived for a sample that consisted of STEM vocational education students. Therefore, the purposive sampling technique was used to select students from the University of Applied Science Saxion located in Enschede (Onwuegbuzie & Leech, 2007). The interpretations of this study remain localized to STEM students, but STEM education consists of a wide diversity in study programs and educational levels. Therefore, we selected two vocational education STEM study programs to strive for diversity via the non-probability sampling strategy, which are: 1) Art & Technology, and 2) Industrial engineering & management (Onwuegbuzie & Collins, 2007). The diversity of STEM is represented in two study programs, where the first program consists of techniques and arts around multimedia projects, whereas the latter program consists of managing in companies where the technical component is important in business operations. In addition, the internship experience is seen as an influential factor on the professional identity development. Internship in both study programs are often planned at the beginning of academic year two and three. To make a distinction in students with and without internship experience, the first and third academic years were selected to

participate in this study. The aim was to thrive for a sample size of around 60 participants of which 50% from program Art & Technology and 50% of Industrial engineering & management.

The recruitment procedure was different for both study programs due to differences in end year study schedules. For both study programs three aspects were mentioned as a motivational factor to engage in this study: a chance at winning 25 euros in a raffle, information via a presentation/workshop on professional identity development and a snack. The first- and third-year students of the study program Art & Technology were recruited via two different methods due to scheduling capabilities. To the first-year students (approximately 80 students) an email was send in which they were invited to participate in this study. After a week a reminder email was sent with a request for participation. In total this led to eight participants. The third-year students completed the essay and questionnaire jointly in the classroom after a mandatory course. All third-year students participated which led in total to 51 participants. The first- and third-year students of the study program Industrial engineering & management were invited to join on a workshop regarding the topic professional identity, where prior to the activity the questionnaire would be filled in for research purposes. Via an email two first-year classes and two third-year classes (approximately 40 students) were invited to participate which was voluntarily and planned in an intermediate hour. As an extra reward the students received 0.1 credits when participating in this study. In total this led to nine first-year and three third-year participants. The total sample size of this study consisted of 71 participants.

The mean age of the participants was 22.04 ($SD = 2.48$), varying from 17 to 29 years. The largest group of participants originated from the study program Art & Technology with 83.1%, while 16.9% of Industrial engineering & management. The distribution of the academic year was 23.9% first-years and 76.1% third-years. In total more males (66.2%) than females (33,8%) participated in this study.

3.3 Instrumentation

In this study an essay as a questionnaire as a quantitative instrument was used to examine the professional identity status and a qualitative instrument was used to examine the professional identity development phase. In the following paragraphs, the instruments and their validation will be discussed.

3.3.1 The Professional Identity Status Questionnaire (PISQ-5d). In order to measure the professional identity status the validated *PISQ-5d* instrument developed by Mancini et al. (2015) was conducted. This instrument included 20 items in total (see Appendix A), which measures 5 dimensions of the identity status (four items per dimension), namely: 1) in-depth exploration , 2) identification with commitment, 3) reconsideration of commitment, 4) affirmation, and 5) practices. The first three concern intra-personal level, where the latter two measure inter-personal processes (Crocetti et al., 2010; Mancini et al., 2015). The items of identification with commitment, reconsideration of commitment, affirmation and one item of practices were scored on a five-point Likert rating scale ranging from 1 (totally not agree) to 5 (totally agree). The remaining three items of practices and the four items of in-depth exploration were measured on a five-point Likert rating scale ranging from 1 (never) to 5 (very often).

In order to identify the underlying components of the questionnaire and to examine the validity of the components a preliminary analysis was conducted on the 20 items via the Principal Component Analysis (PCA) method with oblique rotation. The oblique rotation with the direct oblimin method fits the model of this study, because it was expected that there is some correlation among the dimensions (not orthogonal); the construct professional identity consists of multiple dimensions (e.g., intra- and inter-personal dimension) that interconnect (Costello & Osborne, 2005; Field, 2009; Mancini et al., 2015). The statistics program IBM SPSS (version 25) was used to conduct the PCA. Prior criteria were set for handling the data output, which were: 1) the sample size should be large enough for conducting the PCA, calculated via Kaiser-Meyer-Olkin with a cut-off range set on .6, 2) the number of extracted factors was based on Mancini et al. (2015), nonetheless the eigenvalues should meet the Kaiser criterium of >1. Further, the Cronbach alphas should be checked and indicate an acceptable or high internal consistency, and 3) the factor structure should reveal per dimension a minimum of three items with loadings of >.3 (Costello & Osborne, 2005; Field, 2009). Items would be removed when loading <.3. Cross-loadings were allowed when they were smaller than the primary loading (< .3) (Costello & Osborne, 2005; Field, 2009).

An initial analysis was run whereby the extracted factors was set on 5. However, the analysis revealed that the items of the components *affirmation* and *identification with commitment* loaded on the same factor. Earlier research using the PISQ-5d revealed similar results in which both components were combined into one component *level of identification* (Veldhorst, 2016), which also used in the current study. Following, the extracted factors for PCA were set on 4 and Kaiser–Meyer–Olkin (KMO) measure verified the sampling adequacy for the analysis, KMO = .72. The Bartlett's test of sphericity χ^2 (190) = 571.85, $p < .001$, indicated that correlations (ranging .4 - .8) between items were sufficiently large for PCA (i.e. the correlation matrix compared to the identity matrix, revealed that a number of correlations coefficients were greater than .3 and were significant) (Field, 2009). The four components had eigenvalues over Kaiser's criterion of 1 and in combination explained 56.79% of the variance.

Notable, item number 16 "Do you ever wonder whether the profession you are currently educated for is the most suitable for you?" revealed a cross loading of .543 on dimension *reconsideration of commitment*, whilst loading .419 on its intended dimension *in-depth exploration* (see Table 1). The item failed to meet the criteria set for cross-loading items, however the simply removal of the item from the validated instrument might lead to collapsing factors. Therefore, a procedure of judgment-call was involved to analyse whether the item should be retained or removed (Matsunaga, 2010). The procedure consisted of the following two steps: 1) a theoretical analysis of the content of the item and its cross-loading dimensions, and 2) statistical analysis of the relation between the item and its cross-loading dimensions. The *theoretical analysis* lead to the following findings: the nature of the item is theoretically linked to the dimension reconsideration of commitment, as they are interconnected on the same theme; level of satisfaction with one's current commitment (Mancini et al., 2015). However, the items' main theme concerns whether one further explores, and thereupon fits its originated dimension (Mancini et al., 2015). In other words, because of the interconnected theme in both the dimensions, the attributes are

not concrete and therefore this item can be seen as multi-semantic (Bergkvist & Rossiter, 2007). The *statistical analysis* led to the following findings: if item deleted it would negatively influence the Cronbach's alpha of its dimension; from $\alpha = 6.24$ to $\alpha = 6.04$. Further, the component correlation matrix revealed that the dimensions are related but not significantly correlated. Which indicates that although item 16 is multi-semantic and loads on two dimensions, the dimensions have enough discrepancy. Furthermore, in order to test whether there is a difference in the strength and direction of the association that exists between item number 16 and the two dimensions (on which it both loads), the Spearman's rho test was conducted. The test revealed that there was a medium positive relation between item number 16 and both dimensions, but the difference was small (based on the three remaining items of in-depth exploration, $r_s = .31$, $p < .001$; based on the remaining four items of reconsideration of commitment, $r_s = .42$, $p < .001$). The combination of the theoretical and statistical findings led to the retainment of the item in the dimension in-depth exploration.

The communalities fell within the accepted magnitude .3 - .8 (Costello & Osborne, 2005). All four dimensions had a minimum of > 3 items with factor loading $> .3$, which was set as the absolute minimum value (Costello & Osborne, 2005). Table 1 shows the factor loadings of the items after rotation (pattern matrix). The four components were named 1) in-depth exploration, 2) practice, 3) level of identification, and 4) reconsideration of commitment. Finally, the reliability analysis of the PISQ-5d revealed an acceptable internal consistency for the subscales in-depth exploration (α .62) and practice (α .63), both consisted of four items. A high internal consistency for the subscales level of identification (α .87) and reconsideration of commitment (α .8), with respectively eight and four items.

Table 1.

Summary of exploratory factor analysis results for the Professional identity Status Questionnaire (PISQ5)

Item	Rotated factor loadings			
	Level of identification	Reconsideration of commitment	In-depth exploration	Practice
It is important for me to become a professional in this field	.492			
I feel good about becoming a professional in this field	.375			
I am looking forward to become a professional in this field	.337			
I am proud to become a professional in this field	.388			
Thinking about myself as a professional in this field helps me understand who I am	.608			
Thinking about becoming a professional in this field makes me feel secure in life	.890			
Thinking about myself as a professional this field makes me feel self-confident	.943			
Thinking about myself as a professional in this field makes me feel confident about the future	.767			
If I could change from professional field I would do it		-.665		
I think choosing a different profession would make my life more interesting		-.825		
I think it is better to prepare myself for another profession		-.794		
I am considering to change my study program, to create the possibility to practice another profession in the future		-.791		
Are you ever concerned about becoming a professional in your field?			.809	
Do you ever think about the advantages and disadvantages associated with your professional field?			.724	
Do you ever pay attention to what other people think about your professional field?			.532	
Do you ever wonder whether the profession you are currently educated for is the most suitable for you? *		.542	.419	
Do you ever read books and/or articles written by scholars in your professional field?				-.419
Do you ever seek information about the different job options that your study degree may offer?				-.743
Do you ever seek information about rules and regulations of practicing in your professional field?				-.601
Do you ever participate in meetings and/or conferences where professionals from your field speak?				-.763
Eigenvalues	5.53	1.92	1.35	2.54
% of variance	27.67	9.60	6.79	12.71
Crohnbach's α	.87	.8	.62	.63

Note. * Multi-semantic item

3.3.2 The Professional Identity Development phase Essay. In order to measure the professional identity development phase the *professional identity development essay* instrument was conducted (Bebeau & Lewis, 2003). The essay consisted of four open questions (see Appendix B) to elicit cognitive-emotional-social structures about students' understanding of professionalism in the context of the development of their professional identity (Bebeau & Monson, 2012). The first question focused on the students' impression of the concept professionalism. The second question focused on the students' self-expectations of becoming a professional and others' expectations of the student as a professional. The third question focused on the conflicts that students might experience, in the role of a professional, regarding his/her responsibility to themselves and others. Finally, the fourth question focused on how the student as a professional handles failure or/and not living up to the expectations. Although the instrument was developed for dual purpose, in the current study the instrument was solely used for measurement of the professional identity development phase.

In order to ensure the validity of the essay instrument while translating the questions, the linguistic and conceptual equivalence were tested (Beaton, Bombardier, Guillemin, & Ferraz, 2000). Therefore, the translation procedure consisted of two steps: 1) a back and forth translation, and 2) a pilot test (Beaton et al., 2000). First, the four essay questions were translated to Dutch, and back to English to check for equivalence in translation. The two English versions were then compared. Subsequently the questions were discussed with two researchers to resolve discrepancies. Secondly, at the beginning of this study a pilot version ($N = 4$) was conducted to obtain feedback about the formulation and comprehensibility of the questions. Results from this pilot test revealed the need for a small introduction of the questions, for example "This question concerns the expectations you have of an Art & technology professional, but also about expectations others have of you as a professional".

A codebook was used with permission of the authors, for assessing the four essay questions and subsequently assign the students to one of the phases (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). This codebook was assessed by a developmental psychologist to ensure content validity (Monson & Hamilton, 2011). The convergent validity of this instrument was confirmed by Monson and Hamilton (2011), they revealed that there was a positive correlation between higher stages of identity and post conventional reasoning. The codebook consists of criteria of each development phase per essay question. An example sheet from the coding manual, see Appendix C. In the coding procedure, the raters observe the quotes of the essay question and checks the criteria of each phase. Subsequently, when the students' quotes match a criteria, then the question is assigned to that corresponding phase. The codes were as follows; phase 2 was marked as code 2, transition phase 2/3 was coded 2.5, phase 3 was coded 3, transition phase 3/4 was coded 3.5 and phase 4 was coded 4. The final score was calculated by taking the average of the four questions (i.e. calculation of the number of times raters agree on a rating, subsequently divided by the total number of ratings).

In order to ensure the reliability of observation in the coding procedure, the inter-rater agreement test (i.e. the level of agreement among the coders) was conducted and calculated via the method percent agreement, whereby 15% of the total observations were randomly selected (Boudah, 2011). The percent

agreement was chosen because it records the scores of two independent observers on the same observational data of the same situation (Boudah, 2011). The rules of thumb for percent agreement sets the level of minimal agreement on 75%, with number of ratings <4-5 categories (the number of codes, e.g., 2/ 2.5/ 3/ 3.5/ 4) and with the qualification of no ratings more than one level apart (e.g., phase 2 and transition phase 3/4) (Boudah, 2011; Stemler, 2004). Two raters participated in the inter-rater agreement test; a coder (student MSc. Educational Science and Technology) and the current studies' researcher. Beforehand, the raters discussed the concepts and protocol of coding. Thereafter four essays were coded together and a round of discussion followed to clarify unclear concepts. Finally, ten essays were independently coded by both raters. This resulted in an unanimous judgment for four essay scores. Of the remaining six essays, four scores fell within a half-phase (e.g., 2 and 2/3) and two scores fell within one phase (e.g., 2 and 3). In this study, a half-phase variability (i.e. rating that falls within a half performance level of the rating of the other coder) was set as accepted and counted as agreed for the inter-rater agreement (e.g., 2/3 and 3). This resulted in an overall accepted consistency of 80% in coding that fell well above the benchmark of 75% (Boudah, 2011). The rating schedule was based on literature and on previous equivalent studies where the half stage variability was taken into account, so that credit was given to near misses (Boudah, 2011; Monson & Hamilton, 2011; Stemler, 2004). Furthermore, there were no systematic deviations found in the coding patterns of the coders.

3.4 Procedure

Prior to conducting this study approval from the Ethics committee of the University of Twente was obtained in order to ensure the quality of this study. The heads of two departments from the two study programs, Art & Technology and Industrial Engineering & Management from Saxion University of Applied Science, were approached to participate with their students in this study. Because of end year curriculum study program schedules the participants of both study programs and academic years were recruited via different methods. A detailed description of the recruitment procedure of the participants see paragraph *3.2 Participants*. The questionnaire and essay were conducted via Qualtrics online survey tool (for smartphone, tablet and notebook). In order to avoid socially desirable answers, it was addressed that there are no good or wrong answers. The completion time took approximately 20 minutes. The participants gave permission to participate in this study in advantage by means of informed consent: at the start page of the instrument the students were informed about the research goals and explanation was given regarding the regulations of confidentiality and anonymity of the data. The data collection took place between May and July 2016.

3.5 Data analysis
3.5.1 Preliminary analysis

In the data analysis (*see paragraph 3.5.3*), the parametric assumptions of the statistic tests were checked. But, first a preliminary analysis was conducted by testing the assumption of normal distribution for all separate variables. Although, the linear regression analysis (e.g., ANOVA) do not strictly assume

normality for either independent as well as dependent variable, the test for normal distribution provides insides in the data and indicates, when not normally distributed, to critically look further at the histogram and the normal probability plots (e.g., outliers, distribution of the residuals) (Field, 2009). The normal distribution of the data was investigated via the Shapiro-Wilk test for examining (results see Appendix D). The Shapiro-Wilk test was used for testing the normal distribution, because this test is well applicable for studies with small sample size (Field, 2009). The test revealed significant ($p < .05$) for all the variables. However, when significant level adjusted to .01 α level the test revealed non-significant for the variable dimension *level of identification*, $D(71) = .10$, $p = .017$, suggesting a normal distribution. Furthermore, one univariate outlier was detected on the variable *Reconsideration of commitment*. But when inspecting the data, the participant appeared to rate the maximum highest score on the four items of this variable. Therefore, it was chosen to not remove or change the outlier (Dooley & Vos, 2008; Field, 2009).

Summarizing, based on the preliminary analysis of the data, before each statistical test first the assumptions were tested, *see paragraph 3.5.3*, in favour of conducting a parametric or non-parametric statistic. When these assumptions were violated, the non-parametric tests for data analysis were conducted. This was chosen because the non-parametric tests allows non-normal distribution of the data and uses ranks and medians so that the results are less affected by extreme values e.g. outliers (Dooley & Vos, 2008). In paragraph 3.5.3, the statistical methods used for data analysis will be discussed, including assumption testing. In order to decrease the chance on type I error, the significance criterion for the statistical tests were α *level* .05, when otherwise this is mentioned (De Veaux, Velleman, & Bock, 2016)

3.5.2 Operationalization of the concept natural maturation

Current study's goal was to examine the variations in the professional identity status and professional identity development phase of STEM students, and subsequently to investigate the relation between STEM students' academic year (representing students with and without internship experience) and the professional identity status and the professional identity development phase. Academic year one and three served as the representation of students with and without internship experience. Research indicates that individuals naturally develop a sense of moral reasoning through maturation, for example Kohlberg's theory of moral development suggests that the moral reasoning is strongly correlated to age (Colby & Kohlberg, 1987; Gleitman, Gross, & Reisberg, 2010). Most developmental research suggests that morality is developed until the age of 22 (Gleitman et al., 2010). This is in line with Gardner and Steinberg (2005) which studied, in the trend of the moral development, the risky decision making of adolescents and adults. They found that adolescents were more inclined to show risky behaviour and decision making in comparison to adults (Gardner & Steinberg, 2005). Also the identity development is related to age, for example Erikson's developmental theory and Marcia's identity status theory suggests that during the adolescence (13 – 22) the identity develops and at the beginning of adulthood (24 and older) the identity should be achieved (Erikson, 1950; Marcia, 1966). In the current study the minimum

age was 17 (and maximum 29), accordingly a part of the participants would fall within the adolescence phase. On the other hand, other scientist suggest that the development of an individuals' moral reasoning is a process of lifelong learning (Bebeau & Lewis, 2003; Kegan, 1982). This also applies for professional identity formation, which can be constructed and revised until late adulthood (Ibarra, 2007). For example, Ibarra (2007) found that career changes are successfully made, even when they are voluntary or forced late in adulthood. To conclude, one could say that the personal identity of an individual is developed around the age of 22, but that the professional identity is not age related and continues to develop lifelong (Bebeau & Lewis, 2003; Ibarra, 2007). The personal identity is seen as the basis on which the professional identity can be based, as the adolescences around the age of 22 have established their own identity based on a belief system (Ibarra, 2007).

Furthermore, a preliminary analysis of the relation between age and academic year via a Spearman's rho revealed that, as in line with the expectation, there was a positive significant, $r_s = .413$, $p < .001$ correlation. In order to examine the direction of the association a Mann–Whitney test indicated that the age of the students was greater for academic year 3 ($Mdn = 24$) than for academic year 1 ($Mdn = 20$), $U = 205$, $p = .001$. Therefore, based on the theoretical operationalization and the preliminary analysis, the age variable was included in the data analysis in order to investigate whether the outcomes could be appointed to internship experience or due to natural maturation. In the following chapters, the concept academic year (i.e. one and three) is used to address the students with and without internship experience, when otherwise this is mentioned.

3.5.3 Analysis of the data and assumptions testing

In this study several statistics were used for data analysis. Following a description of these used methods for analysis per study section (i.e. paragraph). Preceded by a discussion of parametric assumptions testing per method. An overview of the current studies variables (e.g., type and level), see Table 2.

Table 2.

Overview of studies variables (e.g., type and level)

Variable	Type	Levels	Studied in paragraph
Professional identity status	Categorical Nominal	Achievement Foreclosure Diffusion Moratorium	4.2 / 4.4/ 4.5
Professional identity development phase	Categorical Ordinal	Phase 2 Transition phase 2/3 Phase 3 Transition phase 3/4	4.3 / 4.4 / 4.5 / 4.6
Academic year	Categorical Ordinal	Academic year 1 Academic year 3	4.5 / 4.6
Age	Numerical Continuous	In years (i.e. 22)	4.6
*Four dimensions of professional identity status**			
Reconsideration of commitment	Numerical Continuous	1, 2, 3, 4, 5	4.6
Level of identification	Numerical Continuous	1, 2, 3, 4, 5	4.6
In-depth exploration	Numerical Continuous	1, 2, 3, 4, 5	4.6
Practices	Numerical Continuous	1, 2, 3, 4, 5	4.6

Note. *The four dimension variables were converted into z-scores

Paragraph 4.2 examines the variations in professional identity statuses among the STEM students. This was established via a *k*-means non-hierarchical cluster analysis in order to investigate whether there is a distinct in subgroups within the sample. Thereafter, the best model fit was examined by running multiple *k*-means with different clusters and the number of clusters in the final model was set on 5 based on Mancini et al. (2015). Subsequently, the analysis of variance (ANOVA) was conducted to assess how distinct the clusters are and whether the dimensions contribute significantly to the formation of the five clusters. Thereafter, to follow up the significant ANOVA results, further analysis were conducted to examine the group differences for each dimension. The homogeneity of variance was tested via the Levene's test. When equal variances was met the post-hoc Bonferroni method was conducted, to control for type I error (Field, 2009). When equal variances was not met, the Games-Howell procedure was conducted, because it does not rely on this assumption (Field, 2009).

Paragraph 4.3 examines the variations in the professional identity development phase among the STEM students. This was established via a qualitative analysis of the essay instrument. The four essay questions were coded with the aid of a validated codebook (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). Thereafter, the qualitative output was quantified for further analysis in this study.

In **paragraph 4.4** the relationship between professional identity status and professional identity development phase was investigated via the examination of the mean differences of the dependent and independent variable. The assumption of homogeneity of variance was confirmed via Levene's test, which showed significant ($F (3, 670) = 1.610$, $p = .195$). Therefore, a one-way ANOVA was conducted, followed up by a post-hoc Bonferroni method, to control for type I error (Field, 2009).

In **paragraph 4.5** the relationship between academic year and the professional identity status and professional identity development phase was examined. This paragraph consists of two subparagraphs in which the mutual relationships were investigated. As one of the aims of this study was to examine the relation between internship experience and the professional identity status and professional identity development phase of STEM students, academic year one and three served as the representation of students with and without internship experience. First, in **paragraph 4.5.1**, the relationship between academic year and professional identity status was investigated with the Chi-square analysis. The assumptions[1] for Chi-square test of independence were verified, with the exception of the last assumption; two cells have an expected count less than 5. However, recent literature addresses that this rule of thumb might be too conservative, as long as no expected counts are <1 and that the standardized residuals are checked so that they do not make the χ^2 statistic too large (De Veaux et al., 2016; Sharpe, 2015). All expected counts were above 1 and there were no large standardized residuals detected in the cells with expected count <5, therefore the Chi-square was used for analysis (De Veaux et al., 2016).

Next, **in paragraph 4.5.2**, the relationship between academic year and the professional identity development phase was investigated via Spearman's rho, because the normality test was violated via Shapiro-Wilk ($p < .05$). Thereafter, followed up by a Chi-square analysis. The assumptions for Chi-square were verified, with the exception of the last assumption; two cells have an expected count less than 5, however no expected counts were <1 and there were no large standardized residuals detected, therefore the Chi-square was used for analysis (De Veaux et al., 2016). Post-hoc analysis were conducted via Cramer's V and the Linear-by-linear test. These post-hoc tests were conducted because they measure the effect size, which decreases type 1 error (Field, 2009). Subsequently, the Jonckheere-Terpstra test was conducted as a follow up the investigate whether there is a trend in the ordered samples (Field, 2009). This test allows to determine whether there is a significant trend between an ordinal independent and ordinal dependent variable (Field, 2009).

In **paragraph 4.6**, the association between the four dimensions of the professional identity status, i.e. reconsideration of commitment, in-depth exploration, practices and level of identification, and two independent variables, i.e. academic year and professional identity development phase, were investigated via the parametric statistic a two-way Multivariate analysis of covariance (MANCOVA).

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[1] The assumptions for the Chi-square test: 1) the data in the cells are counts, 2) the levels (or categories) of the variables are mutually exclusive, 3) the groups are independent, 4) the level of measurement of all the variables should be nominal or ordinal, 5) the sample sizes between the groups should not be too unequal, and 6) rule of thumb ≤20% of the cells with expected counts <5 (Field, 2009; McHugh, 2013).

This statistic was used because it allows the independent variables to be categorical as well as continuous (Field, 2009). Further, it allows for adding a covariate to the model[2]; the variable age was added as a continuous covariate variable to control for the other variables, in order to investigate whether the results could be appointed to internship experience or due to natural maturation (Field, 2009). Furthermore, the parametric MANCOVA test was chosen to conduct because the scores of the four dimensions were converted into z-scores and because it allows for measuring multiple continuous dependent variables (Field, 2009). Furthermore, the use of a MANCOVA reveals an increase in power, compared to using two times an ANCOVA (Field, 2009). The assumptions for the two-way MANCOVA were confirmed[3]. After the MANCOVA a set of univariate ANOVA tests were conducted with post-hoc analysis via a Bonferroni correction to further explore the between-group differences (Field, 2009).

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[2] It should be addressed that the covariate variable age was related to academic year, $r = .40$, but the covariate and independent variable were not highly correlated (Field, 2009). The covariate age was not related to the independent variable professional identity development phase. Further, there is a linear relationship between the four dependent variables (i.e. four dimensions of the professional identity status) and the continuous variable age; however, it should be addressed that these relations revealed to be weak. Therefore, further preliminary analysis was needed to examine whether the two-way MANCOVA could be further continued; test whether the slopes of the lines from the dependent variables to the covariate does not differ across the different groups of the independent variables (i.e. academic year and professional identity development phase) via the homogeneity of slope assumptions, see point 5 in the next indention of assumptions testing (Field, 2009).

[3] First, the assumptions were tested (Field, 2009): 1) there is independence of observations, 2) the dependent variables are moderately correlated, 3) the homogeneity of variances and covariances were checked: the univariate tests of equality of variances between groups was confirmed via the non-significant Levene's test for all the dependent variables. Further, the covariances were compared between groups via Box's M Test of equality of covariances matrices and revealed non-significant, $p = .057$, 4) the normality of the dimension level of identification was confirmed via the Shapiro-Wilk test, the other three dimensions were not. But the probability plots (P-P) for all dependent variables revealed a reasonably straight line, suggesting a normal distribution and therefore all four dependent variables were included in the analysis (Field, 2009), and 5) the homogeneity of regression slopes were confirmed by rerunning the MANCOVA via a customized model and revealed a non-significant effect for all four dimensions, $p > .05$.

4. Results

4.1 Descriptive statistics

The variables of this study were professional identity development phase (i.e. phase 2, transition phase 2/3, phase 3 and transition phase 3/4), professional identity status (i.e. achievement, diffusion, foreclosure, moratorium and searching moratorium), academic year (i.e. year one and three), age and the four dimensions of the professional identity status, which were: level of identification, reconsideration of commitment, in-depth exploration and practices. A correlation analysis was conducted for the continuous and ordinal (i.e. with two categories) variables. Table 3 shows the means, standard deviations and correlations between the variables.

Table 3.
Correlations and descriptive statistics; demographic variables and the four dimensions (N = 71)

| | | Mean | SD | Correlations | | | | | |
				1	2	3	4	5	6
1	Academic year[a]	1.76	.43	--					
2	Age	22.04	2.5	.40**	--				
Four dimensions									
3	Reconsideration of commitment	2.23	.79	.13	-.04	--			
4	In-depth exploration	2.31	.76	.08	-.06	.26*	--		
5	Practices	2.15	.74	.05	.27*	-.01	.22	--	
6	Level of identification: Affirmation & Identification with commitment	3.74	.72	.06	.28*	-.50**	-.19	.26*	--

Notes. [a]Academic year: year one = 1, year three = 2. *Correlation is significant at .05 α level.
** Correlation is significant at .01 α level.

4.2 The different variations in the professional identity statuses of the STEM students

The current studies' exploratory nature fits the exploratory procedure of a cluster analysis. Therefore, a *k*-means non-hierarchical cluster analysis was conducted in order to investigate whether there is a distinct in subgroups within the sample and to classify this data into clusters. The a priori selection of 5 clusters was based on Mancini et al. (2015), which were labelled: diffusion, moratorium, achievement, searching moratorium and foreclosure. The number of iterations was 6 and fell well within default (<10 iterations). In order to assign the five labels to the clusters, a comparison was made between the z-values bar chart of Mancini et al. (2015) and of the current study (see Appendix E and Figure 4). In this comparison the merging of two dimensions (i.e. affirmation and identification with commitment) into one dimension (i.e. level of identification) was taken into account. The analysis revealed a corresponding image of the negative and positive pattern of the dimensions regarding the clusters, with the exception of the dimension *practices* in the clusters *moratorium* and *searching moratorium*. The dimension practices was positive in the current study's cluster moratorium, where Mancini et al. (2015) revealed a negative score.
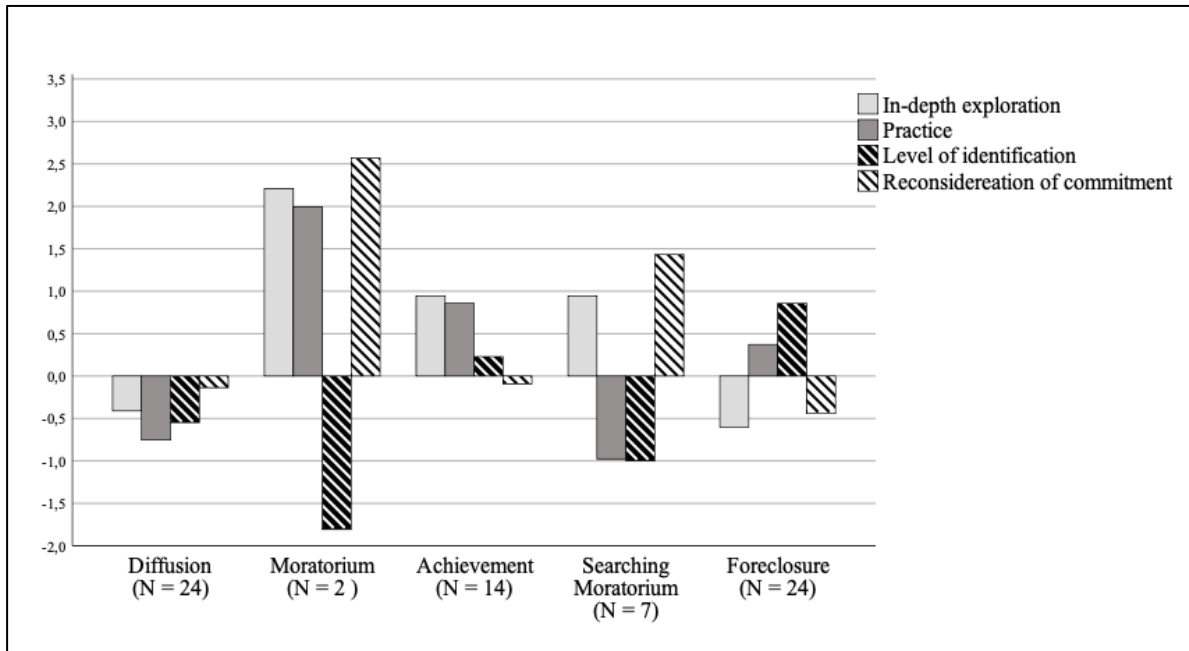
Figure 4. Mean values of the four dimensions for each cluster (z-scores)

Remarkably, the clusters diffusion and foreclosure consisted both of the largest participants group (*n* = 24). Followed by the cluster achievement (*n* = 14), while moratorium (*n* = 2) and searching moratorium (*n* = 7) consisted of the smallest group of participants. The statuses searching moratorium and moratorium were combined for further analysis in this study due to small *n* and together named *moratorium*. The analysis of variance (ANOVA) was conducted to assess how distinct the clusters are. ANOVA revealed a significant different means for all dimensions (see Table 4). Suggesting that all four dimensions contribute significantly to the formation of the five clusters (all *p* < .001). The F-values were ranging from 14.56 to 24.57, the dimension *reconsideration of commitment* revealed the lowest F-ratio contributing the least to the formation of clusters.

Table 4.
ANOVA results of the four dimensions for professional identity status

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Reconsideration of commitment	8.204	4	.563	66	14.560	.000
In-depth exploration	10.312	4	.436	66	23.670	.000
Practices	10.470	4	.426	66	24.575	.000
Level of identification	9.765	4	.469	66	20.831	.000

Note: four-cluster solution based on Mancini et al. (2015)

To follow up the significant ANOVA results, further analysis was conducted to examine the group differences for each dimension. The homogeneity of variance was confirmed via the Levene's test for two dimensions; level of identification and practices (*p* > .05). There was a significant effect of the dimensions level of identification and practices on the professional identity status, with a large effect size, $F(4, 66) = 20.83$, $\eta^2 = .56$, $p < .001$, and respectively $F(4, 66) = 14.56$, $\eta^2 = .60$, $p < .001$. The

assumption of homogeneity of variance was violated for the dimensions in-depth exploration and reconsideration of commitment; therefore, the Welch F-ratio is reported; there was a significant effect of the dimensions in-depth exploration and reconsideration of commitment on the professional identity status, with a large effect size, $F(4, 7.03) = 16.42$, $\omega^2 = .46$, $p = .001$, and respectively $F(4, 6.95) = 24.57$, $\omega^2 = .57$, $p < .001$. A series of post-hoc pairwise comparisons were conducted in order to examine the group differences, see Appendix F.

4.3 The different variations in the professional identity development phase of the STEM students

In order to examine the variations in the professional identity development phases among the STEM students, a qualitative analysis was conducted. Thereafter, the qualitative output was quantified. First, the four essay questions were coded where the unit of analysis included phrases that reflected criteria for each phase (Monson & Hamilton, 2011). The coding manual included tables for each of the four essay questions. Each table consisted of the codes for each phase (phase 2, 2/3, 3, 3/4 and 4); one row that represents the criteria (generally five till sixteen criteria per phase) and one row of corresponding examples of these criteria (Bebeau & Lewis, 2003; Monson & Hamilton, 2011). Examples excerpts of essay question number one from the current study, that were coded based on the coding manual, see Table 5.

Subsequently, the qualitative output from the questions were quantified, as follows; the quotes from the participants on each of the four interview questions (Q) were coded with a phase. The final score (professional identity development phase) was calculated by taking the average of the four questions, e.g. Q1 was coded phase 2, Q2 was coded transition phase 2/3, Q3 was coded phase 2 and Q4 was coded phase 2; $2 + 2,5 + 2 + 2 = 2.13$ (i.e. phase 2). When for example a score fell between two phases, e.g. score 2.25, then the phrases/quotes with richer detail gained more weight in the final score, and subsequently the number of the final phase was rounded in that direction. This final score was used in this study for further analysis. The distribution of the number of college students between the phases ($M = 2.31$, $SD = .86$) was congruent with the expectations of earlier research (Monson & Hamilton, 2011). Where transition phase 2/3 ($n = 28$) and phase 3 ($n = 25$) consisted of the highest rate of students, followed by phase 2 ($n = 13$) and transition phase 3/4 which consisted of the least amount students ($n = 5$).

Table 5.

Excerpts of students' definition of professionalism (essay question one*) by stage and commentary

Stage	Quote	Commentary
Phase 2	I perceive professionalism as the way of dealing with different internal and external influences in a wise and good manner. For example, the reception of a company will always have to act in a customer-friendly and therefore professional manner. A graduate TB student will also have to deal with many influences during his work. He or she must also deal professionally with these influences.	The student speaks of professionalism in terms of success such as competent performance skills e.g. communication
Transition Phase 2/3	You are continuously innovating, improving and managing a business process. This can be done in several areas such as process optimization, supply chain management, quality control, change management and strategy development. As a person you are therefore widely employable in a company, personal aspects are: that you are innovative, flexible, analytical, but that you also dare to take on challenges and are good at cooperation. Of course, personal care/appearance is also important for professionalism.	The student defined professionalism in terms of expertise, but also more enduring internal characteristics are also emerging such as developing interpersonal skills.
Phase 3	Communication towards colleagues and clients: meetings, cooperation, consultation, creating clarity, visiting departments etc. Having sufficient professional knowledge to carry out and substantiate the work properly. This opinion is in line with my standards and values, furthermore my internship period also contributed to this opinion. Keep your word/promise to an agreement, deadlines, etc.	The student internalizes societal and professional expectations and role identities in terms of consonance with their personally held principles and values.
Transition Phase 3/4	I perceive professionalism in my field when you as a professional implement the wishes/concepts of a customer even better than the customer wanted, also when the customer is wrong and you can properly substantiate why something should be done differently, with your knowledge, creativity and experience. In my case, this applies to web applications.	Professionalism is understood by the student in the process of making values of the profession their own and are self-consciously aware of doing so, e.g.: to substantiate why something should be done differently.

Note. * Essay question number one: What does professionalism in the context of your profession (you are currently educated for) mean to you? How did you come to this understanding?

4.4 The relationship between the professional identity status and the professional identity development phase

The frequencies of the professional identity status within the professional identity development phase (see Table 6) showed that in phase 2, diffusion and foreclosure status occurred most often. In transition phase 2/3 the diffusion status dominates, thereafter foreclose and moratorium follow. In phase 3, the status foreclosure, diffusion and achievement occur most often. Finally, in the transition phase 3/4 only two statuses appear, which were achievement and foreclosure.

Table 6.
Frequencies of the professional identity status within the professional identity development phase

Professional identity status		Phase 2	Transition phase 2/3	Phase 3	Transition phase 3/4	Total
Moratorium	Observed *n*	2	6	1	0	9
	Expected *n*	1.6	3.5	3.2	.6*	9.0
	%	2.8%	8.5%	1.4%	0.0%	12.7%
Foreclosure	Observed *n*	5	8	9	2	24
	Expected *n*	4.4	9.5	8.5	1.7	24.0
	%	7.0%	11.3%	12.7%	2.8%	33.8%
Achievement	Observed *n*	1	3	7	3	14
	Expected *n*	2.6	5.5	4.9	1.0	14.0
	%	1.4%	4.2%	9.9%	4.2%	19.7%
Diffusion	Observed *n*	5	11	8	0	24
	Expected *n*	4.4	9.5	8.5	1.7	24.0
	%	7.0%	15.5%	11.3%	0.0%	33.8%
Total	Observed *n*	13	28	25	5	71
	Expected *n*	13.0	28.0	25.0	5.0	71.0
	%	18.3%	39.4%	35.2%	7.0%	100.0%

(Column header spanning: Professional identity development phase)

We wanted to investigate whether the means of the dependent variable, i.e. professional identity development phase, was different among the independent variable, i.e. the four types of professional identity status. The assumptions of the preliminary analyses were met, therefore an one-way ANOVA was conducted and revealed a significant difference between the means of at least one pair of groups ($F(3, 67) = 3.391$, $p = .025$). A series of pairwise comparisons were conducted via post-hoc Bonferroni correction that revealed a significant difference in professional identity development phase between the *moratorium* and *achievement* status ($p = .042$, $r = .13$). Notable, the difference between the *diffusion* and *achievement* status was on the verge not significant ($p = .057$).

The difference between the two significant statuses was also represented in the mean scores; the moratorium status had the lowest score ($M = .89$, $SD = .60$) on the professional identity development phase (coding: phase 2→1; transition phase 2/3→2; phase 3→3; transition phase 3/4→4) while achievement status revealed the highest score ($M = 2.86$, $SD = .86$). The distribution of the professional identity development phases over the two significant professional identity statuses revealed a pattern; a decrease of phase 2 and transition phase 2/3 from moratorium to achievement status, while an increase of phase 3 and transition phase 3/4. Suggesting that students in a higher professional identity development phase (i.e. phase 3 and transition phase 3/4) tend to have a professional identity status with

a higher level of commitment (i.e. achievement and moratorium). While, students with a lower professional identity development phase (i.e. phase 2 and transition phase 2/3) tend to have a professional identity status with low exploration (i.e. foreclosure and diffusion).

4.5 Academic year; representing students with and without internship experience

One of the aims of this study was to investigate the relation between internship experience and the STEM students' professional identity status and professional identity development phase. Hence, in this paragraph the concept academic year was used for internship experience, i.e. academic year one and three served as the representation of students without and with internship experience. In the following paragraphs the relation between academic year (i.e. internship experience) and the two independent variables are investigated.

4.5.1 The relationship between academic year and the professional identity status. In order to examine whether there is an association between academic year and the professional identity status, the Chi-square test of independence was conducted. The test revealed a non-significant association, $\chi^2(3) = 5.682$, $p = .128$. But, when inspecting the distribution of first- and third-year students among the five professional identity statuses, some noticeable aspects should be mentioned, see Figure 5. The diffusion (11%) and moratorium (6%) statuses revealed the highest among first year students. While foreclosure (30%), diffusion (23%) and achievement (17%) statuses were highest among the third-year students.
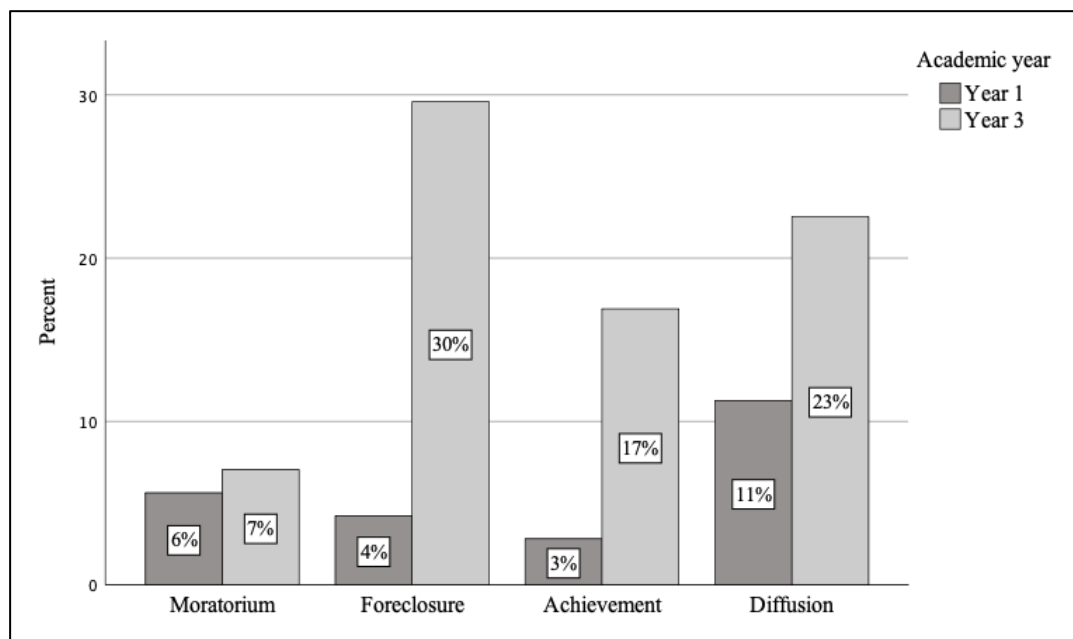

Figure 5. The distribution of academic year over the four professional identity statuses

4.5.2 The relation between internship experience and the professional identity development phase. In order to examine whether there is an association between academic year and the professional identity development phase, a Spearman's rho was conducted to check the relationship. The test revealed that there was significant positive correlation, $r_s = .296$, $p = .012$. To follow up this finding, the Chi-square test was conducted for further examination of the nature of the association (see Table 7). The test revealed a significant association, $\chi^2(3) = 9.015$, $p = .029$. The post-hoc Cramer's V test was conducted for further analysis of the effect size and to determine the strength of the association (Field, 2009). The test revealed significant with a medium effect ($\Phi_c = .36$, $p = .029$). Furthermore, the additional *Linear-by-Linear association* test revealed significant, indicating that the professional identity development phase tends to rise with the values of academic year ($p = .018$).

Table 7.
Distribution of professional identity development phase by academic year (N = 71)

| Academic year | | Professional identity development phase | | | | |
		Phase 2	Transition phase 2/3	Phase 3	Transition phase 3/4	Total
Academic year one	Observed n	4	11	2	0	17
	Expected n	3.1	6.7	6	1.2	17
	%	5.6%	15.5%	2.8%	0.0%	23.9%
Academic year three	Observed n	9	17	23	5	54
	Expected n	9.9	21.3	19.0	3.8	54.0
	%	12.7%	23.9%	32.4%	7.0%	76.1%
Total	Observed n	13	28	25	5	71
	Expected n	13.0	28.0	25.0	5.0	71.0
	%	18.3%	39.4%	35.2%	7.0%	100.0%

The Jonckheere-Terpstra test was conducted for examining whether there is a trend in the ordered samples of the professional identity development phases (Field, 2009). This test revealed significant ($T_{JT} = 632.500$, $z = 2.480$, $p = .013$), confirming the finding that there is a statistically significant trend of higher academic year with higher professional identity development phase (from phase 2, transition phase 2/3, phase 3 to transition phase 2/3). A pattern in distribution differences over the professional identity development phases between *academic year one* and *academic year three* was also revealed by visualizing these finding, see Figure 6. The transition phase 2/3 ($n = 17$) consisted of the highest rate of students for academic year one, followed by phase 2 ($n = 4$). Where for academic year three phase 3 ($n = 23$) consisted of the highest rate of students, followed by transition phase 2/3 ($n = 11$). Notable, consistent with earlier findings (Monson & Hamilton, 2011), transition phase 3/4 consisted solely out of students from academic year 3 ($n = 5$).
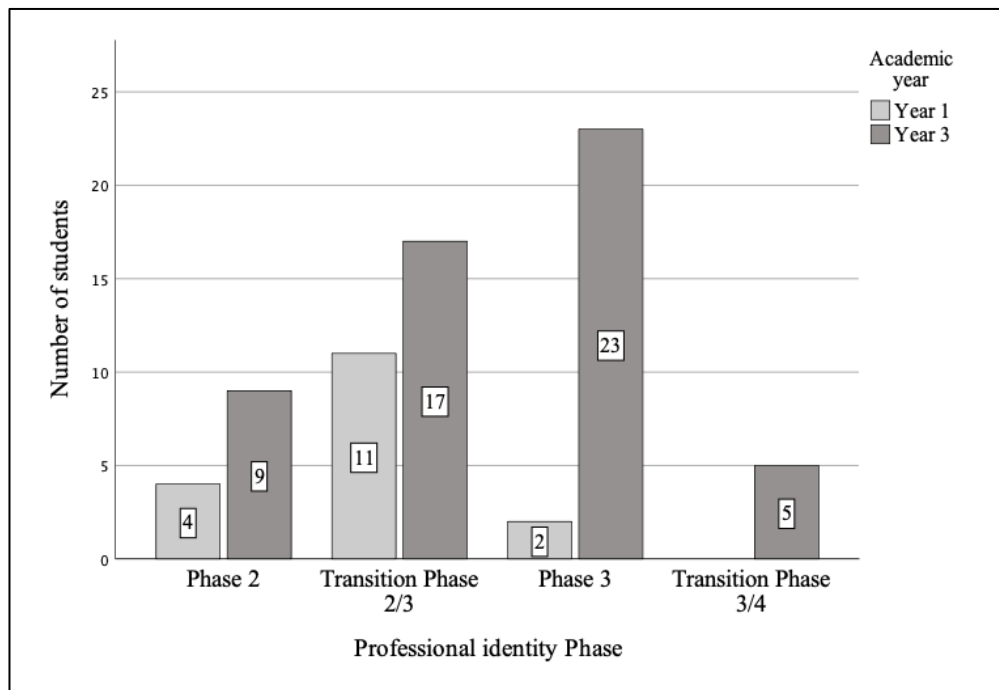
Figure 6. The distribution of academic year over the professional identity development phases (*N* = 71)

4.6 The relationship between the dimensions of professional identity status, the professional identity development phase, academic year and controlled by age.

      In order to examine whether the four dimensions of the professional identity status might be related to the professional identity development phase, a two-way MANCOVA was conducted. Furthermore, one of the aims of this study was to explore the differences between students with and without internship experience regarding professional identity status and development phase. Therefore, the second independent variable that was included was academic year. In this paragraph, the concept academic year (i.e. one and three) was used to address the students with and without internship experience. The covariate that was added to the model was the variable age, because it controlled for the effect of natural maturation as it revealed to be related to academic year (Field, 2009). An overview of the two-way MANCOVA model, see Figure 7. The two-way MANCOVA outcomes revealed one main effect and no interaction effect (Field, 2009), see Table 8.
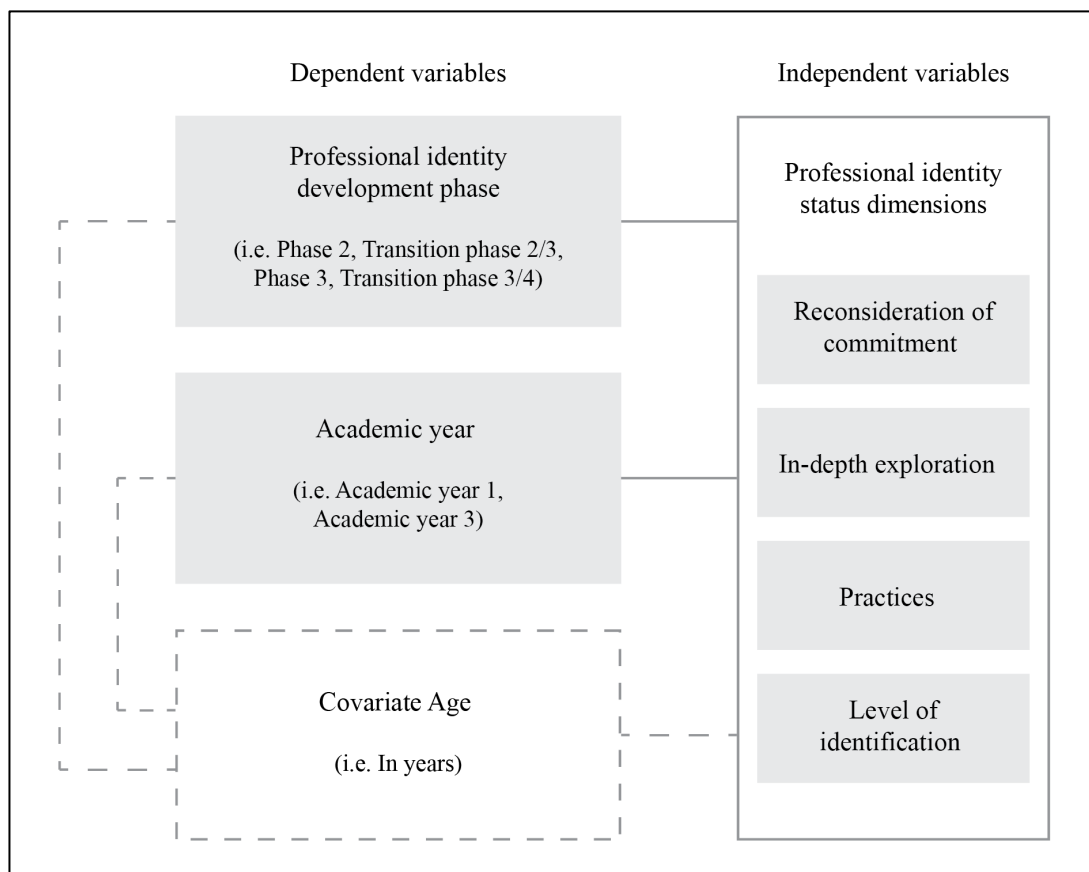

Figure 7. Overview of the two-way MANCOVA model

Table 8.

Results of two-way MANCOVA for the four dependent variables by academic year and professional identity development phase controlled by age

Independent variable	Dependent Variable	*SS*	*df*	*MS*	*F*	*p*
Covariate: Age	Level of identification	3.334	1	3.334	3.790	.056
	Reconsideration of commitment	.598	1	.598	.572	.452
	In-depth exploration	.043	1	.043	.041	.840
	Practices	.106	1	.106	.112	.739
Academic year	Level of identification	6.241	1	6.241	7.094	**.010**
	Reconsideration of commitment	.307	1	.307	.293	.590
	In-depth exploration	1.244	1	1.244	1.190	.279
	Practices	2.012	1	2.012	2.125	.150
Professional identity development phase	Level of identification	1.203	3	.401	.456	.714
	Reconsideration of commitment	2.642	3	.881	.842	.476
	In-depth exploration	2.174	3	.725	.694	.559
	Practices	4.377	3	1.459	1.541	.213

Note. Significant main effect is addressed in bold

The two-way MANCOVA revealed that there was a statistically significant difference between academic year one and academic year three on the combined dependent variables (i.e. the four dimensions of professional identity status) after controlling for age, $F(4, 60) = 3.856$, $p = .007$, Wilks' $\Lambda = .796$, partial $\eta2 = .204$. To follow up this main effect, separate univariate ANOVA tests were conducted and revealed that the difference between academic year one and three solely significantly differed on one dimension: *Level of identification*, $F(6, 64) = 7.094$, $p = .010$. A post hoc analysis with Bonferroni correction was used to control for type I error across the pairwise comparisons and revealed that academic year one ($M = -.67$, $SD = 1.11$) scored significantly lower on the dimension *level of identification* compared to academic year three ($M = .33$, $SD = .91$, *mean difference = .994*, $p = .007$). See Figure 8, for a visual display of the mean scores of the four dimensions of professional identity status within academic year.
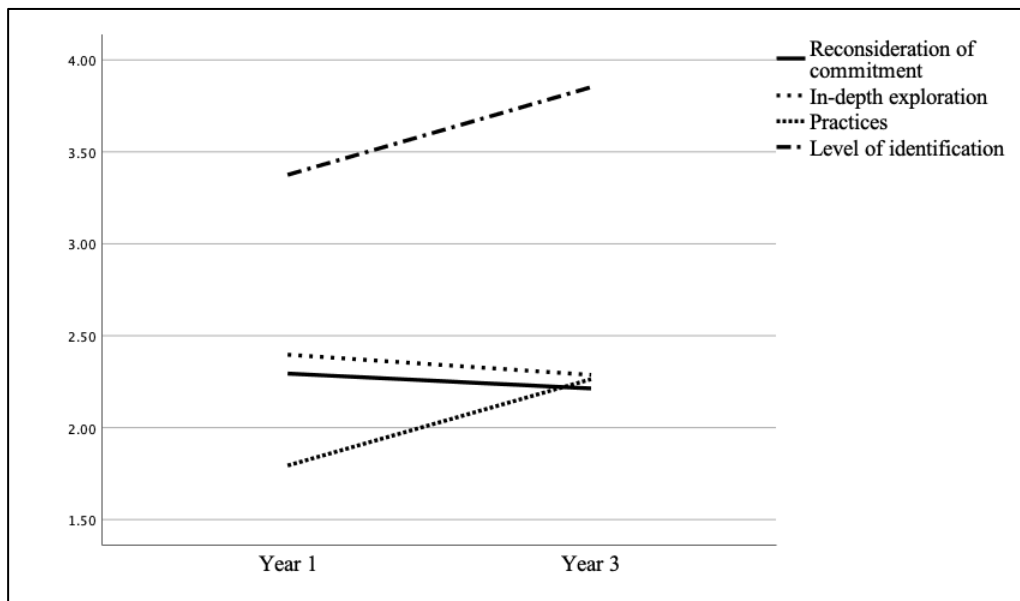
Figure 8. Means of the four dimensions of professional identity status within academic year

The MANCOVA showed that the covariate variable, age, revealed not to be significantly related to the combined dependent variables, $F(4, 60) = 2.232$, $p = .076$, Wilks' $\Lambda = .870$. Furthermore, the results revealed that there was not a statistically significant difference between the professional identity development phases (i.e. phase 2/ transition phase 2/3, phase 3, transition phase 3/4) on the combined dependent variables after controlling for age, $F(12, 159) = .882$, $p = .567$, Wilks' $\Lambda = .843$. But, by visualizing the means of the four dimensions for each professional identity development phase, a pattern could be detected (see Figure 9); an increase of the dimensions *in-depth exploration, practices* and *level of identification,* and a decrease for the dimension *reconsideration of commitment* over the four phases of professional identity development. *In-depth exploration* reveals a trend of increase from phase 2 to transition phase 2/3, decrease transition phase 2/3 towards phase 3, but again in increase from phase 3 to transition 3/4. This might support the findings in research that students in the transition phases are in construction of their identity and reflect on their current commitments while searching for new information (Kroger, 2002; Mancini et al., 2015). Where students in transition phase 2/3 might consider whether they have chosen the right STEM profession, the students in transition phase 3/4 might consider in what direction within their STEM profession they want to specialize in. The *practices* status reveals an overall increase over the phases, which might assume that students are more involved in the content of the profession (i.e., activities and actions) in order to discover specific career choices (Mancini et al., 2015). The status *reconsideration of commitment* reveals a decrease and *level of identification* an increase over the professional identity development phases, which might assume that as students move into a further phase, the level of commitment and satisfaction towards the chosen STEM profession becomes higher, while the need for exploring alternative commitments reduces. In transition phase 3/4 the students seem not to reconsider their commitment with the profession, but reveal an increase on in-depth exploration, practices and level of identification. This finding is in line with Mancini et al. (2015), where they found a significant relation between the dimensions and named it the status achievement.
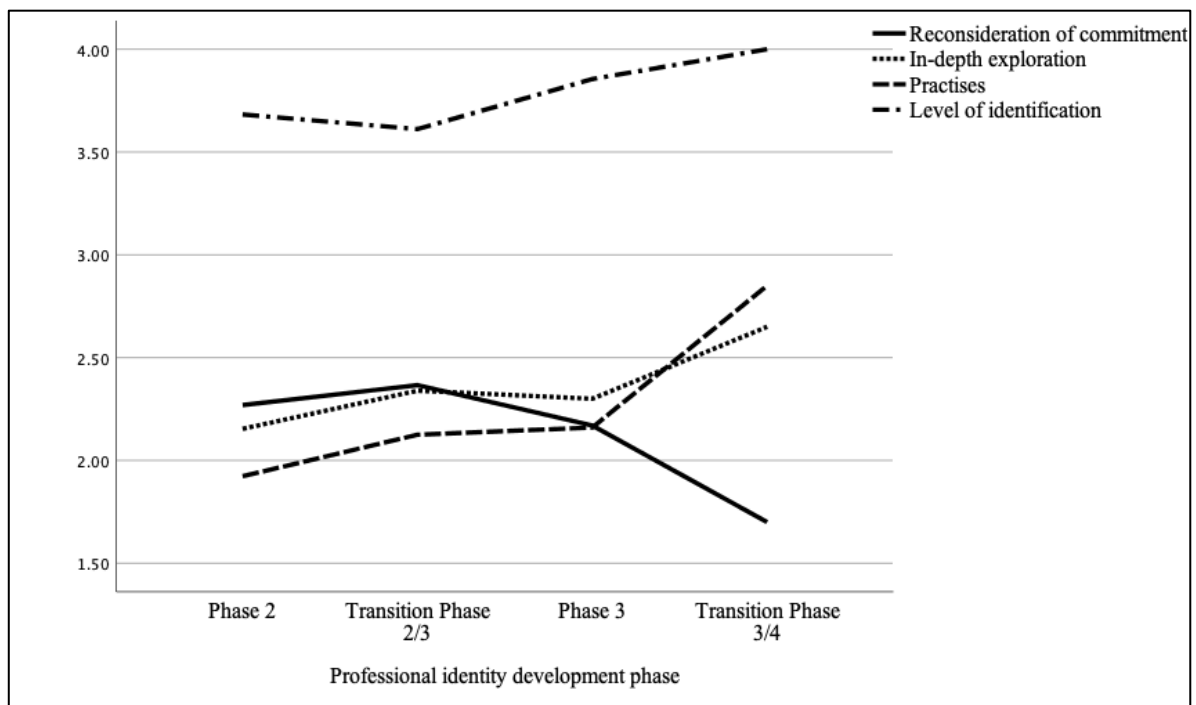
Figure 9. Mean scores of the four dimensions for each professional identity development phase

5. Conclusion

The goal of this study was to investigate the different variations in the professional identity development of higher vocational education STEM students, and how this is related to their academic year (representing students with and without internship experience). First, this study revealed that STEM students differ in their professional identity status, where the largest group of students revealed a diffusion and foreclosure status, showing that these students differ in their level of commitment, while both tend to score low on level of exploration. But, when we delve more deeply into the different academic years, differences emerge; the first academic year students scored highest on diffusion and moratorium status, while foreclosure, diffusion and achievement were the highest among third academic year students. Further, when inspecting the four dimensions of the professional identity status, this study revealed that students in academic year three, compared to students in academic year one, score higher on the dimension level of identification and practices. Suggesting that students of academic year three have a higher feeling of belonging and a sense of pride to be a member of a profession, while the need for exploring alternative commitments reduces and in turn, undertake activities and actions to discover specific career choices. While students in academic year one reveal a higher need for (re)considering their commitment with the profession and to explore this commitment in-depth, through critical questioning their educational choices.

Second, this study revealed that STEM students differ in their professional identity development phase, where transition phase 2/3 was the largest group among academic year one students and phase 3 was the largest group among academic year three students. Showing that students in academic year one define their professional identity based on external authorities, while students in academic year three more and more reveal to self-define their professional identity. Furthermore, this study revealed that in total 47% of the participants were in a transition phases (i.e. transition phase 2/3 and transition phase 3/4). Results revealed that students in these transition phases score high on in-depth exploration, and are in construction of their identity. But, there is a difference between the students in transition phase 2/3, whom might consider whether they have chosen the right STEM profession, and the students in transition phase 3/4, whom might consider in what direction within their STEM profession they want to specialize in. In total 18% of the students are positioned in phase 2, which revealed to score high on reconsideration of commitment; these students are active in searching meaning for educational possibilities. In total 35% of the students are positioned in phase 3, which reveal to score low on reconsideration of their commitment, while the score on practices and level of identification increases. These students show professional behaviour by engaging and undertaking activities in the professional domain.

To conclude, this study revealed that the STEM students in vocational education differ in their professional identity development phase. Further, the internship experience seems to have an association with the developmental phase. Each developmental phase in the formation of a professional identity consists of certain characteristics, which may be addressed in the counselling support for the STEM

students. Because, the type and moment of support and the level that students are actively involved in their professional identity development might have consequences for their professional identity and further career choices.

6. Discussion

This study consisted of four sections that were investigated in order to study *the variations in the professional identity development of STEM students in higher vocational education, and how this is related to their academic year.* First, this study investigated the different variations in the professional identity statuses of the STEM students. Second, the different professional identity development phases of the STEM students were investigated. Third, the relationship between professional identity status and the professional identity development phase was investigated. Finally, the relationship between academic year (i.e. internship experience) and the professional identity status and professional identity development phase was studied. In this chapter, the outcomes on each section and the theoretical implications will be discussed. Followed by an appointed series of practical implications and future directions. Thereafter, the methodological strengths and limitations of this study will be reviewed. To summarize, this chapter ends with a final conclusion.

6.1 The different variations in the professional identity statuses of the STEM students

This section focussed on the different variations in the professional identity statuses of the STEM students. Via a cluster analysis the profiles for the different types of STEM students were established. The designation of the five profiles was based on the 5 cluster solution based on Mancini et al. (2015). Results from the preliminary analysis revealed that the components *affirmation* and *identification with commitment* loaded on the same factor. This might be explained by the main concept, i.e. *commitment*, that both components include and measure. Whereas *affirmation* is seen as an inter-personal process that refers to a sense of pride and belonging to a professional category, *identification with commitment* is rather seen as an intra-individual cognitive process that refers to making informed choices towards an identity and the activities that are undertaken to confirm these choices (Mancini et al., 2015). Therefore, in the current study both components were combined; *level of identification.* The other three dimensions were: *in-depth exploration, reconsideration of exploration,* and *practices*. Five profiles were identified with corresponding negative and positive pattern of the dimensions as in Mancini et al. (2015), which were: diffusion, foreclosure, moratorium, searching moratorium and achievement. The results revealed that a remarkable 33,8% of the students were identified with a *diffusion* and also 33,8% with a *foreclosure* status. Students in the diffusion status scored negative on all four dimensions; the students do not explore or commit to a profession. Students in the foreclosure status scored negative on reconsideration of commitment and in-depth exploration, while positive on level of identification and medium on practices; the students made commitment to the roles and values of the profession, but without exploration (Mancini et al., 2015). The *moratorium* and *searching moratorium* status were combined due to a small count and led together to 12.7% of the students. The score in this status differed with Mancini et al. (2015), where the dimension practice in the current study revealed negative, where Mancini et al. (2015) revealed a positive score. In-depth exploration and reconsideration of commitment scored positive, and negative for level of identification; the students

explored the roles and values of the profession, but without making commitment or reconsider their commitment (Mancini et al., 2015). Lastly, 19,7% of the students were identified with an *achievement* status. Students in the achievement status scored positive an all dimensions with the exception of a negative score on reconsideration of commitment; the students explored the roles and values of the profession and commitment has been made to the profession.

A recent study, that was also conducted in the context of STEM students using the PISQ-5d, revealed that the highest group of participants were located in the searching moratorium status (Veldhorst, 2016), while in the current study the foreclosure and diffusion consisted of the largest group. Hence, it was expected for the current study also to consist of the largest participants group in the (searching)moratorium status. This difference might be due to the excluding criteria of Veldhorst (2016); to exclude first- and second-academic year students. Furthermore, the results from Veldhorst (2016) and the current study correspond. However, where Veldhorst (2016) mentioned lower scores on practices in the achievement status, in the current study and Mancini et al. (2015) the students revealed to practices more in the achievement status.

In Mancini et al. (2015) the cluster searching moratorium consisted of the largest group of participants (i.e. Psychology students), while in the current study the clusters diffusion and foreclosure consisted of the largest group of participants. In the current study, STEM students seem to commit more to the profession, but explore less, in comparison to Mancini et al. (2015) where Psychology students explore more and reconsider their commitment. This aspect might address the differences between educational content. Psychology students are often at an early stage in their education confronted with self-reflection and development, whereas STEM educations experience difficulties in implementing self-reflection in the educational content (Kirschner, 2017; Woudt-Mittendorff, Pullen, & Kornet, 2018). But, this can also be biased by the small number of participants of the current study and gender inequality. In Mancini et al. (2015) the gender distribution was not evenly distributed in favour of women (88,9%), while in the current study the gender distribution was in favour of men (66,2%). Recent brain research discovered that a men's brain contains more grey matter compared to a woman's brain (Gleitman et al., 2010). This influences their behaviour, e.g. men tend to handle tasks with a single-minded focus, whereas woman tend to include surrounding matters in their approach (Gleitman et al., 2010). Therefore, men might more directly opt for a profession, where women might tend to explore more the different professional domains and options. But, there have not yet been studies that reveal reliable sex differences regarding identity status.

The high rate of diffusion and foreclosure statuses in the current study might also be explained by the students' type of choice for an STEM study program. According to Dehing et al. (2013) there are two types of choices students make for an education, which are: 1) a choice for a specific profession within a discipline, or 2) a choice for the discipline as a knowledge field, without having a specific profession in mind. The identity development best fits with the first choice to enter a study program (Dehing et al., 2013). In this study the largest group of participants is represented from the study program Art & Technology (83.1%). This study program attracts students that have often chosen for this

profession based out of interest in the domain field of creativity in combination with technology, and often not so much specific for a profession (Hobéon, 2012). This might explain why the diffusion and foreclosure status consist of the largest participants group.

6.2 The different variations in the professional identity development phases of the STEM students

This section focused on the different variations in the phases of the professional identity development of the STEM students. This study showed that *transition phase 2/3* and *phase 3* consisted of the highest rate of students, respectively 35% and 39%. While the remaining 16% is divided over *phase 2* and *transition phase 3/4*. This is in line with earlier research in the same context of higher vocational education (Hamilton & LaVoi, 2017; Monson & Hamilton, 2011). Students in transition phase 2/3 see themselves and others as individuals with own interests, but they have an increased ability to meet others or professions' expectations. Therefore, in the development these students need to be guided in obtaining mastery level beyond technical skills (Bebeau & Monson, 2012; Kalet et al., 2018). While students in phase 3 see the shared interconnections between themselves and others. These students are able to take multiple perspectives in social situations and therefore are able to accordingly adapt their sense of self (Bebeau & Monson, 2012). The complex framework of the next developmental phase is characterized by the development of the identity that is self-defined. Therefore, in the development these students need to be guided by making meaning of the self, not based on external authorities, but internally defined, i.e. on one's own moral, values and interests (Bebeau & Monson, 2012).

6.3 The relationship between the professional identity status and the professional identity development phase

This section focussed on the relationship between professional identity status and the professional identity development phase. This study revealed that there was a significant difference in professional identity development phase between the moratorium and achievement status; moratorium revealed lowest score, while achievement revealed highest score on professional identity development. Furthermore, the non-significant findings revealed, in line with earlier research (Kroger, 2002), that in phase 2 the diffusion status occurred most often and phase 3 the foreclosure status occurred most often. Thereby the achievement status only occurred in the highest rated phase, namely transition phase 3/4. It would have been expected that the statuses moratorium and searching moratorium dominated in the transition phases, but this was not found. This might be explained by the appearance of reflection while the students are in a transition phase; the searching moratorium status suggests that students have not yet made a commitment, while this study revealed that students have made commitment towards the profession in the transition phases, but that they reflect upon their current commitment (Bebeau & Monson, 2012; Mancini et al., 2015).

An aspect on which both two theories are aligned is the capture of the development phase in which the individual is on the verge of leaving his/her identity and concurrently enters a new identity

(Ibarra, 2004; Levinson, 1981). In the professional identity development theory by Bebeau and Lewis (2003) these are represented in the transition phases (i.e. 2/3 and 3/4). In the professional identity status theory of Mancini et al. (2015) these are represented in the diffusion and (searching)moratorium status. This study underpins this notion; 39,3% the students that are positioned in transition phase 2/3 are located in the diffusion status. The transition phase is important in the development of a professional identity, as it determines whether you stay with the current commitment or revise your commitment (Ibarra, 2004). In recent time many researchers have identified steps in the transition phase. The most famous one is Bridges' transition model, which is constituted out of three steps: 1) ending, i.e. the individual detaches from his/her professional self, i.e. leading to confusion, denial and frustration, 2) neutral zone, i.e. the individual seeks for solutions for this undefined state, i.e. from resistance through creativity the individual explores new options, and 3) new beginning, i.e. the individual forms and reconstructs a new identity leading to relief and a high state of commitment (Bridges, 1980; Ibarra, 2004). It is important that study counsellors can identify when a student is in a transition phase, so that the student can be guided in this difficult phase; not let students skip steps in order to accomplish a successful transition (Ibarra, 2004). Therefore, it would be interesting for future research to investigate the transition model in STEM education.

6.4 Academic year; representing students with and without internship experience

This section focused on the relationship between academic year and the two independent variables: the professional identity status and the professional identity development phase. This study showed that the academic year was not related to the professional identity status, however there was a difference in most common identity status; diffusion and moratorium in academic year one, while foreclosure, diffusion and achievement in academic year three. This might be explained by students' uncertainty for the professional domain in academic year one, but in academic year three the students have made commitment towards the chosen identity in the profession, but have not yet engrossed in the career choices within the profession domain (Mancini et al., 2015).

Furthermore, this study showed that the professional identity development phase significantly tends to rise with academic year (i.e. from academic year one to academic year three). Academic year one students recorded most often transition phase 2/3, whereas for academic year three this was phase 3. This finding is in line with earlier research that suggests that vocational education students often develop their professional identity from phase 2 towards phase 3 during their education. While from the moment they graduate and start their career in the professional field, they start to develop towards phase 4 the self-defining professional (Hamilton & LaVoi, 2017; Monson & Hamilton, 2011).

6.5 The relation between the dimensions of professional identity status, the professional identity development phase, academic year and controlled by age.

This section focused on the relationship between the four dimensions of the professional identity status and two independent variables: the professional identity development phase and academic year. Academic year represented the students with and without internship experience. The age variable was included in this study (i.e. as a covariate) to control for the effect of natural maturation.

The outcomes revealed a significant relation between academic year and the dimension level of identification; students from academic year one scored lower on this dimension, compared to academic year three students. The other dimensions were not significant, but a pattern could be detected: the dimension reconsideration of commitment decreases from academic year one towards academic year three, as similar with the dimension in-depth exploration. But the dimensions level of identification and practices increases over the academic years. Furthermore, there was not a significant relation between the dimensions and the professional identity development phase. However, a pattern was found; in phase 2, students score quite low on practices, but score rather high on level of identification. On one hand this seems remarkable, but on the other hand this might be explained by the fact that they have just begun to investigate their professional identity and have opt for this certain profession (Dehing et al., 2013). In transition phase 2/3, students score low on the level of identification, where students might consider whether they have chosen the right profession in the STEM domain. In phase 3 the level of identification increases, whereas the level of reconsideration of commitment decreases. This pattern continued in the next phase; transitional phase 3/4. In line with earlier research, the students in transition phase 3/4 score high on in-depth exploration; students consider in what direction within their STEM profession they want to specialize in.

6.6 Combined set of findings; level of exploration & commitment and internal vs. external self-definition

The two instruments conducted in this study, i.e. the questionnaire on professional identity status and the essay on professional identity development phase, could be used in the educational context to provide the study counsellors with insights in the developmental areas of the STEM students' professional identity. Whereas the first, the professional identity status questionnaire, could be used for trajectory measurement with small intervals (e.g. biannually) to detect fluctuations in the style the student adopts towards the profession. The differences in the outcomes of the questionnaire provide insight into what direction the student develops and whether the supervision should be adapted to guide and support the student as effectively as possible. Whereas the latter, the professional identity development phase essay, revealed to detect the students' trend in development and whether this trend corresponds with the "regular" growth curve of the professional identity development. Therefore, it could be used for measurement with larger intervals, i.e. biennially. The measurement differences could provide inside in whether the student stagnates in his/her development or/and where the focus areas of development lies.

The combined set of findings from both instruments, i.e. the professional identity status and the professional identity development phase, revealed a differences in pattern regarding students' activities in their professional identity formation between first- and third-academic year students. A visualisation of the observed findings on professional identity development, see Figure 10 (PI abbreviation for Professional Identity). The first year students revealed a professional identity development cycle consisting of four steps; 1) the student explores his/her options about the variety of professional identity possibilities, 2) the student commits towards a professional identity, 3) the student begins to identify with the professional identity, and 4) the student behaves as a professional based on an external appointed set of rules and defines his/her professional identity based on external authorities, i.e. teachers. The third year students revealed a professional identity development cycle consisting of four steps; 1) the student explores his/her professional identity more in-depth through practising the content of the profession e.g. by undertaking activities to discover specific career choices, 2) the student reconsiders his/her commitment towards his/her professional identity by comparing different commitments. When there is a positive outcome in the form of a fit between the students' commitments, e.g. values, goals, and the commitments of the professional identity, the student continues in developing his/her professional identity. However, when the current commitments are no longer satisfactory, the student begins to (re)discover his/her professional. 3) the student identifies with his/her professional identity by having a sense of pride towards the profession and his/her contribution to the profession, and 4) through metacognition the student self-defines his/her professional identity, while he/she is able to take multiple perspectives.
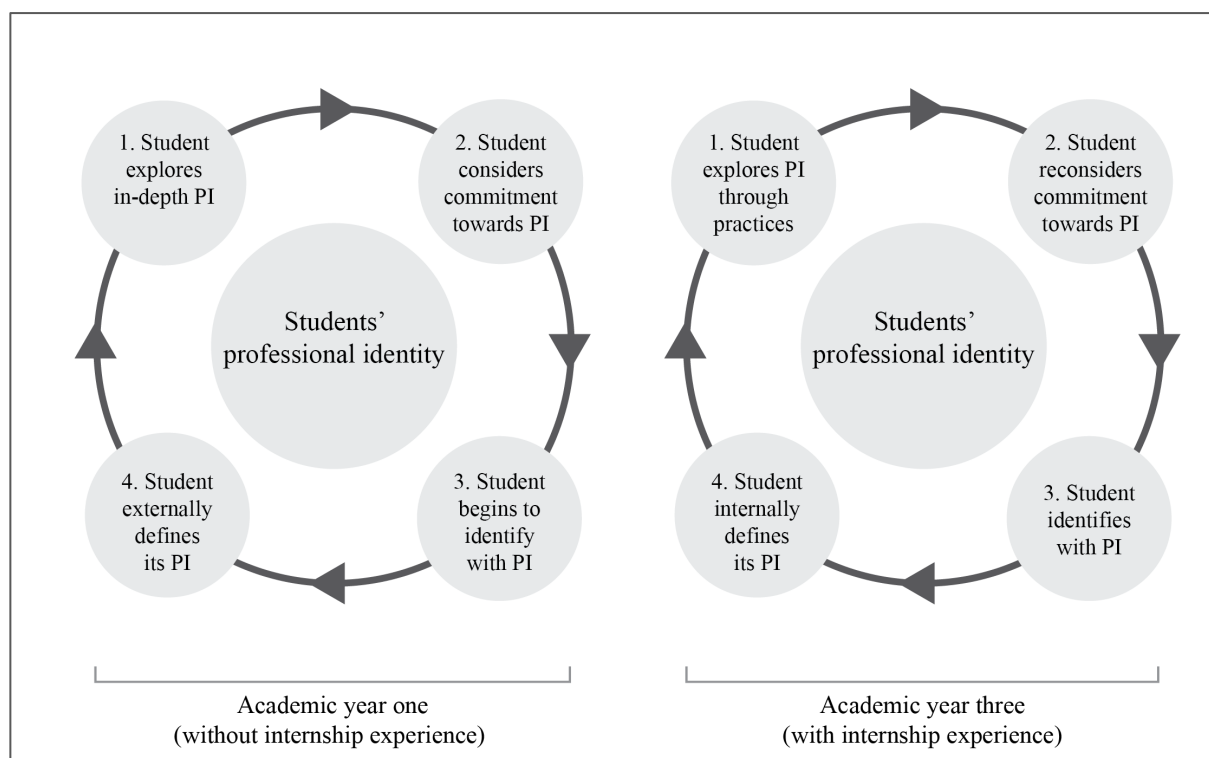

Figure 10. Visualisation of the observed findings on students' professional identity development

The current studies' results regarding differences between academic year one and three are addressed to students without and with internship experience. Therefore, this study proposes that internship experience tends to be a crucial *event* in the curriculum of students. Research indicates that *events* in a students' education are necessary in order to transition further onto a well developed professional identity (Ibarra, 2003). Ibarra (2003) suggests that an event itself does not necessarily produce the change, but rather causes a set of exploration and experimentation. The founders of both theories conducted in the current study, Erikson (1950) and Kegan (1982), indicate that an event is an important factor in the formation of an identity. According to Kegan (1994) three components should interact, in order for an individual to make meaning of an event; 1) cognitive i.e. obtaining an understanding of his/her internal belief systems, 2) inter-personal i.e. ability to participate in relationships with others, while considering the others' perspective, and 3) intra-personal i.e. ability to make an internal defined sense of the self, for example by formulating ones' own values (Baxter Magolda, 2008). While this study proposes that internship can be seen as an event that has a major influence on the development of a professional identity, what more can be seen as an event needs to be further investigated. More importantly, the events that trigger a transition can be an external event, e.g. exposure to role models, role-emerging placements, fieldwork, as well as an internal event, i.e. an internal emotional and cognitive process leading to an internal revision (Ibarra, 2003). The internal events are more difficult to measure as they are personal and a subjective process (Ibarra, 2004). Therefore, further research is needed for identifying and operationalizing the concept *event*.

6.7 Practical implications and future directions

A number of practical implications arose from this study. First, this study revealed that it would be advisable to take the different development phases of the professional identity with its associated characteristic features into account in the support of the STEM students. The type of support needs to be adjusted to the students' phase of professional identity development in order to be effective; when there is no fit students experience the support as not valuable (Loui, 2005; Woudt-Mittendorff et al., 2018). For example, students with a diffusion status need support in clarifying the personal identity and arising therefrom explore what profession would fit him/her, while students in the foreclosure status need guidance in exploring their current commitment towards the profession, so that they are confronted with a realistic perspective on that profession. Another example, almost half of the participants were located in one of the transition phases (i.e. 2/3 and 3/4). This entails that students in the transition phase undertake activities to consider their commitment to the profession while searching for new information (Bebeau & Monson, 2012). Therefore, these students might have a need for activities that provide the possibility to obtain more knowledge about the profession they currently opt for and the career possibilities. A feature that these activities need to include is letting the students being perceived, by themselves as well by others, as professionals and perform the tasks and responsibilities that are associated with this role (Dehing et al., 2013; Mancini et al., 2015). Several recent studies revealed that this positively influenced the students development and identity construction (Dehing et al., 2013;

Mancini et al., 2015). An example activity might be the organization of *a practical case assignment* in which the STEM students are intentionally exposed to conditions of a profession in a workplace environment (Dehing et al., 2013). This provides the students with workplace learning and exposure to professional models, which gives the students new information about the profession enabling them to decide whether or not to proceed to commitment towards the profession (Dehing et al., 2013; Ibarra, 1999; Mancini et al., 2015).

The second practical implication concerns *creating awareness of the concept professional identity development* among STEM students. As the development of a professional identity can be seen as a learning and development process, the three fundamental dimensions of learning are applicable, which are; 1) content, involving knowledge, understanding and skills, 2) incentive, involving emotion, motivation and volition, and 3) interaction, involving action, communication and cooperation (Illeris, 2011). Dimension one and two can been seen as the intra-personal process and dimension three as the inter-personal process. This supports the assertion that the development of a professional identity is a combination of cognitive, social and emotional process in which transformative learning occurs (Hoare, 2006; Kegan, 1982). The three fundamental dimensions of learning and the combination of the inter- and intra-personal processes are in line with the theories on professional identity development by Bebeau and Lewis (2003) and Mancini et al. (2015). This indicates that learning is essential in the process of meaning making during the professional identity development, which means that "the movement is from adherence to rules and procedures with little awareness of practice context, to more intuitive knowing embedded in a deep situation awareness" (Hoare, 2006, p. 47; Kegan, 1982). This addresses the importance of creating awareness of the concept of professional identity development among STEM students and including this theme in the content of the STEM education. In the design of the (reflective) activities, the three dimensions of learning (i.e. cognitive, social and emotional) and the two development processes (i.e. inter- and intra-personal) should be integrated, so that the students can make meaning of the events that occur in the development of their professional identity.

A number of future directions arose from this study. First, in the current study the qualitative data was quantified, so that it could be used for comparison with the quantitative data of this study. However, the essay questions contain valuable qualitative data, which would be interesting to further analyse. The qualitative essay questions might allow a deeper and more explicit discussion of the theme's that occur in the developmental phases while the students construct a professional identity. Second, the current study collected data at one point in time (i.e. cross-sectional), but it would be interesting to examine via longitudinal research whether the professional identity status, its dimensions (Mancini et al., 2015), and the professional identity development phase (i.e. the internal/external self-defined professional identity) reveal to emerge in trajectories over time and what pattern would emerge. A meta-analysis, of longitudinal studies regarding the identity status trajectories by Kroger et al. (2010), revealed that there were significantly more identity progressions than regressions, i.e. in the course over time students moved more often in the direction of achievement than diffusion (Meeus et al., 2012). This was supported by a recent five-wave investigation by Meeus et al. (2012) in the context of early-

to-middle and middle-to-late adolescents. However, it should be addressed that Kroger et al. (2010) also found that about half of the participants remained by their initial identity status and did not change over time. Third, in the current study academic year one and three represented the students with and without internship experience. The findings revealed that academic year is associated to the professional identity status and the professional identity development phase. However, a cause or/and effect conclusion cannot be achieved on the findings of the current study. Therefore, it would be interesting to investigate via a longitudinal study how the students in academic year one transition towards academic year three and its influences on the students' professional identity status and development phase. To further investigate whether internship experience might have a causal relation with the professional identity status and the professional identity development phase, it might be interesting to conduct an experimental study to elicit and detect a more into detail effect of internship experience, e.g. students that have not yet experiences with an internship; where the experimental group participates in a simulation that represents an internship experience.

6.8 Methodological strengths and limitations

The mixed method approach of this study can be addressed as a methodological strength, because the combination of the qualitative essay and the quantitative questionnaire allowed for a deeper understanding of the professional identity development phenomenon (Johnson, Onwuegbuzie, & Turner, 2007; Onwuegbuzie & Collins, 2007). The two methods and theories by Mancini et al. (2015) and Bebeau and Lewis (2003) regarding professional identity development were conducted in order to obtain different but complementary data to grasp the phenomenon from different perspectives (i.e. triangulation) (Johnson et al., 2007). The sets of findings were compared, combined and an interpretation was made; whether the results support or contradict each other (Johnson et al., 2007).

The findings of the current study need to be considered by some important limitations. First, the recruitment method was different for the academic years as well as for the study program. For example, the students from academic year three of the study program Art & Technology filled out the questionnaire and essay classical after a mandatory lecture, while academic year one students were contacted and invited via email to participate. As a result, this might have created a skewed picture of the population and the intended sample 50/50% of the participant distribution was not achieved. The response rate from the two study programs led to 23.9% academic year one students and 76.1% academic year three students, this notification must be taken into account.

Second, the current exploratory study consisted of 71 participants. This number of participants fits the qualitative research part of this study. However, for the quantitative part a larger sample size would be preferable in order to make sure that there is enough data to draw solid conclusions on and in order to decrease the chance on type II error (De Veaux et al., 2016). For example, in the current study there were correlations found, but not always significant. This indicates that there was not always enough data to establish a significant correlation, but there were trends in the data identified. Therefore,

the current study's exploratory nature provides a glimpse on the phenomenon professional identity development, on which further research with large-scale samples can be based.

Third, some limitations regarding the professional identity status questionnaire should be mentioned. The original questionnaire was developed for Psychology students, while in the current study conducted for STEM students. As discussed in paragraph 6.1, there are some differences in educational content between Psychology and STEM education that might have influenced the results, e.g. awareness of self-development and reflection skills. Therefore, more large-scale studies are necessary to validate the questionnaire for STEM students. Furthermore, the questionnaire has not yet been standardized (Mancini et al., 2015). Therefore, in this study the scores were converted into z-scores, because z-scores enable a comparison of performance across tests with varying distributions (De Veaux et al., 2016). The z-scores of the current study were compared to the z-scores of Mancini et al. (2015). Based on the z-scores (the negative and positive pattern) of the dimensions, the clusters were assigned to a status. However, using z-scores has a pitfall, i.e. it magnifies small differences that might influence the results (De Veaux et al., 2016). For example, the judgement of negative (low) and positive (high) pattern comes fairly close in assessing the clusters, while the z-scores might have created an increased high score while actually there is a small difference. This has been taken into account in data analysing, but it might have influenced the results.

Fourth, some limitations regarding the professional identity development essay should be mentioned. This study attempted to minimize the threats of external reliability of the essay measure by conducting the percent agreement to measure the level of inter-rater agreement between the two raters (Boudah, 2011). On one hand, the percent agreement took the half stage variability into account, so that credit was given to near misses (Boudah, 2011). On the other hand, the percent agreement failed to measure for chance agreements (Boudah, 2011; De Veaux et al., 2016). The current study's rated sample size ($n = 10$) was too small for conducting a Cohen's Kappa. Therefore, it is advisable to rate a high sample of essays, so that the inter-rater reliability Cohen's Kappa can be conducted that takes the risk on chance into account (De Veaux et al., 2016). Furthermore, the essay was conducted and assessed in studies by developmental psychologists, while in the current study the essays were assessed by two educationalist students. The codebook, from Bebeau and Lewis (2003) and validated by Monson and Hamilton (2011), was used in this study with permission of the authors. However it should be addressed that the current researchers were not trained in the use of the coding criteria (i.e. measuring of moral capacities). On the other hand through theoretical investigation of the subject, they gained basic knowledge concerning the subject matter.

Moreover, what also is important to mention is that the essay on professional identity development attempts to measure students' moral reasoning. However, the essay measures how students' write about their moral decision-making, rather than how they actual behave in practice. There are mixed results from studies on the relationship between moral judgment and moral behaviour (Leman et al., 2012). Some studies suggest that moral judgment is not always related to moral behaviour; by asking for moral judgment, it is not always possible to say whether the person would actually behave

like that (Leman et al., 2012). On contrary, other studies revealed that there is a link between a person's moral maturity and the likelihood that he/she will actually behave morally (Leman et al., 2012; Rest, Narvey, Thoma, & Bebeau, 1999). Therefore, it might be interesting for future research to study both judgment as well as behaviour regarding the professional identity development, e.g. through observations or/and role play, and whether this corresponds.

6.9 Final conclusion

The professional identity development of STEM students has not yet been investigated much, while there is a need to bridge the knowledge gap on providing the STEM students with the appropriate support and guidance in their professional identity formation. The current study has made a first step in discovering what developmental phases STEM students go through while constructing a professional identity. This study showed that STEM students develop through different phases of professional identity development and that these phases are characterized by different features; internal vs. external defined professional self and the variations in the level of commitment and exploration. Also, this study proposes that internship experience (i.e. represented by first- and third academic year students) tends to be associated with the professional identity development and even may accelerate the formation, but this needs to be further investigated. The pragmatic and scientific value of the current study is that it provides insights in the phenomenon of the professional identity development of STEM students. On its turn, these insights provide understanding in where STEM students' growth opportunities lie and how to guide them in the wide range of choices they can make regarding potential professional routes.

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Appendix A - Professional identity status questionnaire (PISQ-5d)

Dimension	Item	Statement/ question	
		Dutch	English
Affirmation	1.	Het is voor mij belangrijk om een professional te worden in dit vakgebied	It is important for me to become a professional in this field
	2.	Ik voel me op dit moment goed om professional te worden in dit vakgebied	I feel good about becoming a professional in this field
	3.	Ik kijk er naar uit om professional te worden in dit vakgebied	I am looking forward to become a professional in this field
	4.	Ik ben er trots op om professional te worden in dit vakgebied	I am proud to become a professional in this field
In-depth exploration	14.	Maak je je wel eens zorgen over het worden van een *Kunst en Techniek* professional?	Are you ever concerned about becoming a professional in your field?
	15.	Denk je wel eens na over de voor- en nadelen van het worden van een *Kunst en Techniek* professional?	Do you ever think about the advantages and disadvantages associated with your professional field?
	16.	Schenk je wel eens aandacht aan wat anderen zeggen over het vakgebied waar je nu voor studeert?	Do you ever pay attention to what other people think about your professional field?
	17.	Vraag je je wel eens af of het beroep waar je nu voor studeert het beste bij je past?	Do you ever wonder whether the profession you are currently educated for is the most suitable for you?
Practises	18.	Lees je weleens boeken en/of artikelen geschreven door anderen binnen jouw vakgebied?	Do you ever read books and/or articles written by scholars in your professional field?
	9.	Ik zoek informatie over de verschillende baan opties welke ik heb na mijn afstuderen	Do you ever seek information about the different job options that your study degree may offer?
	19.	Zoek je weleens informatie op over de reglementen van jouw vakgebied in de praktijk?	Do you ever seek information about rules and regulations of practicing in your professional field?
	20.	Neem je weleens deel aan ontmoetingen en/of conferenties waar anderen van jouw vakgebied spreken?	Do you ever participate in meetings and/or conferences where professionals from your field speak?
Identification with commitment	5.	Denkend aan mezelf als professional in dit vakgebied zorgt ervoor dat ik begrijp wie ik ben	Thinking about myself as a professional in this field helps me understand who I am
	6.	Denkend aan mezelf als professional in dit vakgebied zorgt ervoor dat ik me zeker voel in het leven	Thinking about becoming a professional in this field makes me feel secure in life
	7.	Denkend aan mezelf als professional in dit vakgebied maakt me zelfverzekerd	Thinking about myself as a professional this field makes me feel self-confident
	8.	Denkend aan mezelf als professional in dit vakgebied zorgt	Thinking about myself as a professional in this field makes

		ervoor dat ik me zeker voel over de toekomst	me feel confident about the future
Reconsideration of commitment	10.	Als ik iets anders zou kunnen worden dan een professional in dit vakgebied, zou ik dat doen	If I could change from professional field I would do it
	11.	Ik denk dat een ander beroep mijn leven interessanter maakt	I think choosing a different profession would make my life more interesting
	12.	Ik denk dat het beter is om mezelf voor te bereiden op een ander beroep	I think it is better to prepare myself for another profession
	13.	Ik denk erover na om een andere studie te kiezen zodat ik de mogelijkheid heb een ander beroep uit te voeren in de toekomst	I am considering to change my study program, to create the possibility to practice another profession in the future

Notes. Questions adapted from Mancini et al. (2015). The first thirteen items are scored on a five-point Likert rating scale ranging from 1 (totally not agree) to 5 (totally agree) and the last seven items on a scale ranging from 1 (never) to 5 (very often).

Appendix B - Professional identity development phase Essay questions

Dutch	English
1. Deze vraag gaat over hoe jij professionaliteit ziet in de context van jouw toekomstig beroep als …… (*Kunst en Techniek professional/ Technisch bedrijfskundige*). Hoe zie jij professionaliteit binnen het vakgebied waar jij nu voor aan het studeren bent? Hoe kom je tot deze mening?	1. This question is about the impression you have of professionalism. What does professionalism in the context of your profession (you are currently educated for) mean to you? How did you come to this understanding?
2. Deze vraag gaat over de verwachtingen die je hebt van een …….. (*Kunst en Techniek / Technisch bedrijfskundige*) professional, maar ook van de verwachtingen die anderen van jou hebben als professional. a. Wat verwacht je van jezelf in je ontwikkeling van student naar een professional binnen het vakgebied waar je nu voor aan het studeren bent? b. Wat verwachten anderen (zoals docenten en toekomstige klanten) van jou als professional binnen het vakgebied waar je nu voor aan het studeren bent?	2. This question is about the expectation you have of an ……. (*Art and Technology / Industrial engineering and management)* professional. a. What will you expect of yourself as you work toward becoming a professional (you are currently educated for)? b. What will others (such as teachers and future customers) expect from you as a professional (you are currently educated for)?
3. Welke dilemma's ervaar je op dit moment en/of welke verwacht je in je toekomstige baan na je afstuderen te ervaren tussen de verantwoordelijkheid naar jezelf en naar anderen (bijvoorbeeld familie, klasgenoten, stagebegeleider, klanten tijdens je stage en collega's)? Hoe denk je hiermee om te gaan in de toekomst?	3. What conflicts do you experience or expect to experience between your responsibility to yourself and others (such as parents, family, friends, colleagues, community of the profession)? And how do you resolve them?
4. Deze vraag gaat over hoe jij als professional omgaat met falen en/of met het niet voldoen aan de verwachtingen. a. Wanneer zou je voor jezelf het gevoel hebben dat je faalt als professional binnen het vakgebied waar je nu voor aan het studeren bent? b. Wanneer zou je voor jezelf het gevoel hebben dat je faalt als professional binnen jouw vakgebied ten opzichte van de verwachtingen van anderen (zoals docenten, stagebegeleiders of klanten)?	4. This question is about how you as a professional handle failure or/and not living up to the expectations. a. What would be the worst thing for you if you failed to live up to the expectations you have set for yourself (in becoming a professional you are currently educated for)? b. What would be the worst thing for you if you failed to live up to what others (such as your study counsellors and teachers) expect from you as a professional (you are currently educated for)?

Note. Adapted from Bebeau and Lewis (2003); Monson and Hamilton (2011)

Appendix C - Example rubrics of coding manual

Coding manual: The following descriptions of phase and transition phase of identity development were adapted from the scoring guide developed by Bebeau and Lewis (2003), grounded in Kegan (1982) theory, to assess distinctions they saw in professionalism essays. Criteria and description were modified by Monson and Hamilton (2011), representing the distinctions of the relevant phases and transition phases (examples are from entering law students and alumni).

The following rubric shows the criteria, for each phase, for essay question four: 4a. What would be the worst thing for you if you failed to live up to the expectations you have set for yourself (in becoming a professional you are currently educated for)? 4b. What would be the worst thing for you if you failed to live up to what others (such as your study counsellors and teachers) expect from you as a professional (you are currently educated for)?

Stage 2: The Independent Operator	
Criteria	**Examples**
• failure is black and white: success = feel good, failure = feel bad • failure is expressed in specific concrete terms, as concrete ramifications to self interest • when failure occurs, there is an absence of taking personal responsibility • lack of recognizing personal responsibility is sometimes expressed as blame-shifting (not meeting patients' expectations versus acknowledging responsibility for failing as a professional) • lack of self reflection or self inquiry concerning failures (do not question why failure occurred or how to prevent it from happening in the future) • absence of recognition concerning how their failures may have hurt or impacted others (lack of interpersonal and moral sensitivity; lack of perspective taking) • concern about consequence of failure is negative impact on self interest • motivation not to fail is to avoid punishments/consequences imposed by others or the profession (lack of focus on how they themselves feel and think about themselves as a result of failing others) • if they consider how others will view their failures or shortcomings, their concern is stated in concrete terms of self interest	Having a less-than-ideal financial state and/or family life. I would like to own a nice home in a nice neighborhood, travel often, and have a fabulous wardrobe, and I would be upset to have to give up any of the above. I think that if I fail to live up to my expectations, I would have to start from scratch. The worst professional consequence of failure would be to lose the opportunity to work in the legal field. I would flunk out of law school and have to work as an administrative assistant for the rest of my life. I could be fired, sued, jailed, disbarred, ostracized, etc. The worst thing for me if I failed to live up to the expectations of my clients would be that I would lose their business, if I failed to live up to my firm's expectations the worst thing would be to be fired, if I failed to live up to the expectations of the bar or broader society, the worst thing that would happen would be losing my license to practice law. My morale would be hurt if I failed to meet my expectations. If I fail to live up to my expectations, the worst thing for me would be to not enjoy my job or not utilize my law degree. Failure in itself (if I cannot, in turn, later rise to success) is the worst thing in itself.
Stage 2 / 3 Transition	
Criteria	**Examples**
• increasing focus on internal feeling of guilt for failing to meet others' or the profession's expectations • failure might be expressed in specific concrete terms but relationship issues and abstract qualities are acknowledged (respect, trust) • descriptions of effects of failure may acknowledge ramifications to others but is	My parents' disappointment if I was not able to secure a job after graduation. The worst thing for me would be simply knowing that I failed at what I set out to do, that those I care about might think I didn't try hard enough. The worst consequence for my not living up to my expectations of myself will be offending someone in a way for which I cannot make up.

still expressed in terms of loss to self interest (concern that patients are satisfied with work not for the patients' best interests but for reasons of self interest) • can express feelings of guilt or shame, but includes an element of self interest	Experiencing their anger/sadness/disappointment; being fired; being disbarred; or not being respected, being a "lawyer joke" There would probably be a great internal struggle between what I wanted and what others wanted for me.

Stage 3: The Team-Oriented Idealist

Criteria	Examples
• failure means failing to meet shared, collective obligations (focus beyond simply enacting concrete role behaviors) • failure evokes feelings of guilt or shame over letting down themselves and others • focus is how others will view their failures or shortcomings and how they themselves feel and think about themselves as a result of failure (focus beyond self interest; self reflective) • express a strong sense of obligation to be the right sort of person who others in the profession would view positively, based on their identification with the profession • emerging willingness to take responsibility for their actions and failures	For each of these groups [self, clients, firm, society] I think the worst consequence would be offending them, losing their respect, and being unable to work through the problem. The shame from failure is the worst thing I can imagine. This will fade throughout law school, but as of now I see that as the worst part of being a lawyer. I do not like to disappoint the people who trust me and rely on me, so to disappoint my clients and/or my firm would torture me. I am a person who will go to the edge of the Earth to not disappoint people who I respect and those who respect me, so ultimate failure would be torturous, regardless of the form it comes in. If I failed to live up to my clients, I would be very disappointed in myself as after the experience I had working for an attorney who considered to have done poor work, I feel that I want to always treat my clients with respect. I know there will be times when a client is not satisfied with the outcome of their case, but I want to be able to walk away from each case knowing I did the best I could. If I were to disappoint my firm, I believe the worst thing would be to give up. I would rather like to be able to turn around and work extra hard at the next thing I can do to make it up. To fail to live up to the expectations of the bar would mean that I would not be practicing ethically. If that is that case I believe that I should not be practicing law.

Stage 3 / 4 Transition

Criteria	Examples
• upset when they have failed to take responsibility for their own actions • upset when they discover they have engaged in self-deceptive practices or actions that contradict their own emerging values of professional conduct • sometimes acutely aware of instances where they compromised their own values because of strong organizational or social pressures • emerging internal compass that is in the process of evolving	The worst thing for me if I failed to live up to my clients would be if I hurt them in any way, financially or otherwise because I wasn't able to perform, if I let the bar and my firm down and made their lives more burdensome because I couldn't fulfill what was expected of me, and that I would hinder society or contribute to the negative outlook that society has on lawyers as a whole. Whether or not you failed is reliant on the relation between your expectations and reality. This can only lead to an introspective reflection and an opportunity to improve.

• if failure is expressed as affecting concrete self interests, this is secondary to remaining true to an internal compass • failure might be expressed in terms of idealistic standards	

Stage 4 The Self-Defining Professional

Criteria	Examples
• -failure is viewed in terms of believing that they have not lived up to their self-validated internal standards • -failure may result in considerable personal distress and second-guessing of their decisions • -they are distressed when their internal system of principles and values is revealed as flawed	The worst thing to me would to become so engrossed in my profession that I would forget what is important in life. I would not be a fulfilled person because I would lose sight of the value system in life that serves as a compass for me. I would feel as if i missed an opportunity to promote a positive change in our society. If I fail it will most likely be because I have allowed myself to fail. To feel that I have let myself down would be the hardest part. The worst failure would be to betray my basic personal values and damage my spiritual well being.

Appendix D - Results of Shapiro-Wilk test for testing normality

Variable	*Shapiro-Wilk* Statistic	df	Sig.
Professional identity development phase[4]	.870	71	.000
Professional identity status[5]	.842	71	.000
Four dimensions of professional identity status			
Reconsideration of commitment	.902	71	.000
In-depth exploration	.929	71	.001
Practices	.948	71	.005
Level of identification *	.958	71	.017

Note. *Not significant at .01 α level

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[4] Nominal variable retrieved via the *k*-means non-hierarchical cluster analysis based on the four dimensions, resulting in four professional identity statuses that are distinguished: moratorium, foreclosure, achievement and diffusion.

[5] Ordinal variable retrieved via qualitative essay instrument, resulting in five professional identity phases that are distinguished: phase 2, transition Phase 2/3, phase 3, transition phase 3/4 and phase 4.

Appendix E - Figure Mean values of the five dimensions per cluster
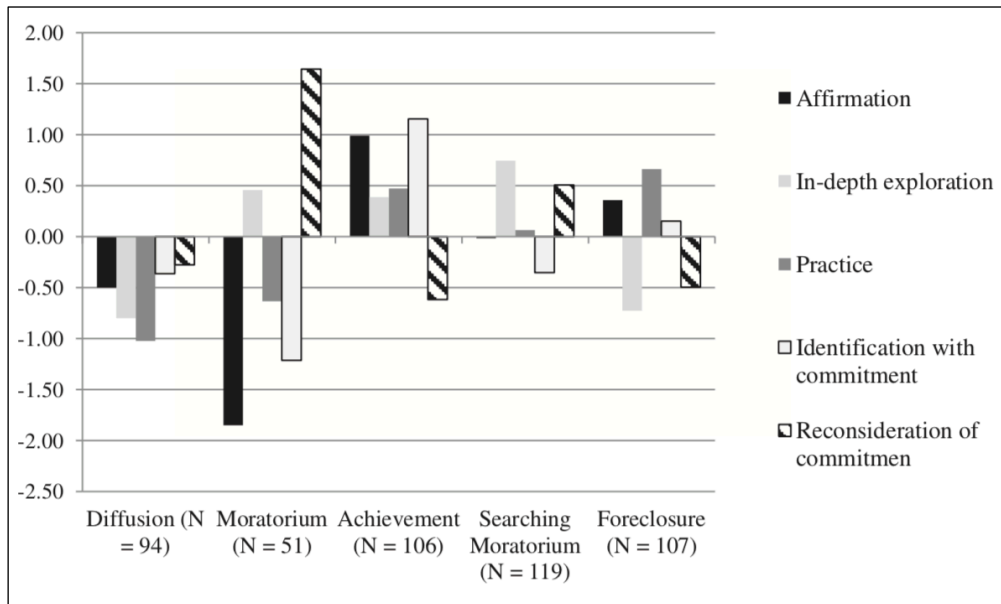

Figure E. Mean values of the five dimensions per cluster; z-scores of Mancini et al. (2015)

Appendix F - Results of pairwise comparison

The post-hoc with Bonferroni correction was conducted for the dimensions level of identification and practices, see Table. The test revealed a significant difference between all five groups of the professional identity status on level of identification, with the exception of a non-significant difference between groups; moratorium and searching moratorium, moratorium and diffusion, foreclosure and achievement. The test revealed a significant difference between all five groups on practices, with the exception of a non-significant difference between groups; moratorium and achievement, foreclosure and achievement, searching moratorium and diffusion. For the dimensions in-depth exploration and reconsideration of commitment, where homogeneity could not be assumed, Games-Howell post-hoc tests were conducted. The test revealed a significant difference on in-depth exploration between the groups; foreclosure and achievement, achievement and diffusion. The test revealed no significant difference on reconsideration of commitment between the five groups.

Table F.
Results of pairwise comparison of the four dimensions by professional identity status

Dimension	Professional identity Status	*Mean*	*SD*	1	2	3	4	5
Level of identification	1. Moratorium	-1.81	1.60	--				
	2. Foreclosure	.86	.54	**2.66**	--			
	3. Achievement	.23	.60	**2.03**	.63	--		
	4. Searching moratorium	-1.00	.87	.81	**1.86**	**1.23**	--	
	5. Diffusion	-.55	.74	1.26	**1.40**	**.78**	.45	--
Reconsideration of commitment	1. Moratorium	2.60	.45	--				
	2. Foreclosure	-.44	.69	3.01	--			
	3. Achievement	-.09	.80	2.66	.35	--		
	4. Searching moratorium	1.43	1.36	1.14	1.89	1.52	--	
	5. Diffusion	-.13	.53	2.71	.31	.05	1.57	--
In-depth exploration	1. Moratorium	2.21	.46	--				
	2. Foreclosure	-.60	.51	2.81	--			
	3. Achievement	.946	.60	1.26	*1.55*	--		
	4. Searching moratorium	.946	1.11	1.26	1.55	.0	--	
	5. Diffusion	-.41	.68	2.62	.19	*1.36*	1.36	--
Practices	1. Moratorium	1.99	.72	--				
	2. Foreclosure	.37	.70	**1.62**	--			
	3. Achievement	.86	.86	1.13	.49	--		
	4. Searching moratorium	-.98	.47	**2.97**	**1.35**	**1.83**	--	
	5. Diffusion	-.75	.49	**2.75**	**1.23**	**1.61**	.22	--

Notes. Significant Bonferroni addressed bold, Significant Games-Howell addressed italic